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AMERICAN WATER WORKS ASSOCIATION

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VOL. 14 JULY, 1925 No. 1

HOW JONESBOROUGH STARTED ITS WATER WORKS[1]

By BEEKMAN C. LITTLE[2]

Of course years ago it was not Jonesborough at all. Those who lived in that neighborhood which was sometimes designated as the cross roads, received their mail only when it was addressed with the right number after the mystic letters R. F. D. But following the Rural Free Delivery came the Ford, and a little later the place was known as Stop 6 on the new Interurban Trolley line which had become very popular almost from the first car which was sent through this section.

Some time later the great state, of which this small community seemed such an unimportant part, decided to improve the main road running through the local four corners, and make it a part of the celebrated State Highway System.

That summer, the old stone house fronting on the road and belonging to the Jones Farm, became the headquarters and boarding-house for the State Engineers and some of the Contractors men, who were employed in building the new road. Such a crowd is apt to give a place a bad name, but these men did not run true to form. Anyway they aimed high.

The name Jonesborough stuck and the people unconsciously tried to live up to the responsibilities which this fine sounding name seemed

[1] Presented before the Louisville Convention, April 29, 1925.

[2] Superintendent, Water Works, Rochester, N. Y.; Secretary, American Water Works Association.

to them to imply. The Jones Farm house thus started on a new career, appeared before long as the "Jonesborough Inn" and, situated advantageously on the now much travelled highway, received considerable tourist patronage, and thrived thereon. With it thrived the adjacent market gardeners and also the little meat-market, the grocery and the general store. Each season found several more houses added to the settlement, and now and then some new venture in the way of a small factory found it advantageous to locate in this vicinity, because of high taxes and other mounting overhead expenses existing in the nearest neighboring city.

There was not any question about it—Jonesborough was growing and was satisfied and happy. Then came the catastrophe. The canning factory down by the creek caught fire and burned to the ground.

Jonesborough's growth had been so rapid, and yet so placid, that nobody had thought seriously about the danger or possibility of a big fire. It was not a large factory, as such go nowadays, but it was big for Jonesborough and its destruction was a great blow. It however aroused the people to the necessity of doing something against the recurrence of a like calamity.

"What we need" said two or three of the leading men "is a fire engine." What you need first is a water works plant, said a young woman visitor, "and perhaps you will not have to have a fire engine."

She was a former Jonesboroughnian who had married one of the afore-mentioned State Engineers and had evidently imbibed some of his knowledge and opinions.

From this beginning, the campaign for a water works got under way. So many favorable arguments arose for the proposition that it seemed queer the project had not been taken up long before.

The proprietor of the Inn was one of the most enthusiastic rooters. He had always served good food, furnished clean beds and was noted for his real genial hospitality, and yet he had continually found it necessary to apologize for the lack of proper water fixtures and bathing facilities. Tourists, it seemed, were forever comparing his old-time makeshifts with the modern plumbing arrangements they found in other places where they stopped.

The Postmaster, for by now the Government had recognized Jonesborough, wanted the new work to start at once, as his well had gone dry two summers in succession. He further stated that every once in a while he received, as Postmaster, letters from prospective

visitors to Jonesborough, asking about the quality—and, sometimes—the quantity, of the water supply, and he had always been ashamed to reply. Perhaps the greatest boost—and the word is a good one to use here—came from the Fire Insurance Companies. Only a very few people up to this point had taken out fire insurance, and the others, now beginning to investigate, were startled and dismayed at the prospect. The fire insurance agents wanted the business, but had to admit that the rates were almost prohibitive and the risks not very good at that. Inquiry about insurance charges in other small places revealed that those with a public water supply were able to get very much lower rates. This fact the insurance men impressed upon the people and told them to remember that this saving in insurance cost would be an offset to the expense of installing a water system. At a suggestion from one of these agents, a meeting was called of all those interested in the proposition, and a representative from the State Board of Fire Underwriters gave an address on the advisability of getting a public water supply. He stressed of course the fire protection phase of the matter but emphasized also the many other benefits arising. The immediate increased value of the real estate and the attraction to the community of additional visitors and possible residents, and more and larger business enterprises. He spoke of the many conveniences and the better living conditions which would supersede the present methods of private wells, entailing as they did the carrying of water—in most cases by hand—winter and summer, into their houses and barns.

The talk was a good one, for the Insurance Underwriters have men well qualified and eager to thus advertise the advantages and urge the adoption of public water systems. Just before the close of the meeting, the village doctor added a few words. Old-fashioned maybe, and yet learned and wise in his profession, he was listened to with attention because he was a friend to all of them, and family physician to most of them. He told of the unsanitary surroundings of some of their wells, and reminded them of the typhoid epidemic some years before—due to just such conditions. With conviction in his voice he told them that a recurrence of this dread disease was not only possible, but very probable, unless a better way was found of supplying the people with water for drinking and cooking purposes.

It was pretty well agreed at this meeting that Jonesborough ought to have a public water supply, and a committee was formed to investigate and report back, at some later meeting, the best method of procedure for obtaining this civic improvement.

The committee was not by any means composed of the obsolete type of small town Yokels, as depicted on the cheap vaudeville stage or in the comic magazines. They were, as is generally the case, the leading citizens, and in these days such men—average up pretty well in intelligence—even in the smaller towns or villages—with a like group in many of the larger cities. Make no mistake about that!

The daily papers, the ubiquitous telephone, the radio, the Saturday Evening Post and several other similar, modern, accessible, information bureaus are developing fairly well informed citizens out of the dwellers in even the most remote and back-woodsy hamlets.

This particular committee showed its common sense right at the start when each admitted to the others that he did not know much—if anything—about the matter in hand. They therefore arranged, for an early date, a trip to the nearest city, there to interview and get if possible, some tips from the Superintendent of that City's rather famous Water Bureau.

In the interim, each one was to get, elsewhere as he might, any information that would be of aid to the committee. It is interesting to record that there is no easily obtained written word on the best method—or any method—of taking the preliminary steps for the establishment by a community of a public water supply system. Many books and valuable papers have been issued on the "Proper sources of Public Water Supplies," the "Purification of Water." "The Construction and Management of Water Works Systems," and on various other phases of this Public Water Works question, all worth while to the civil engineer or water works man, but none of them are of much use to the inhabitants of a community which as some one has stated," is just large enough to have outgrown family wells and is now groping around for a public supply."

One of the committee had written for information to the engineer husband of the young woman who had first suggested the Jonesborough Water Works. His reply rather frightened the committee when it was read. He told them that he could not advise them on the matter as his work was mostly in the line of development and construction of good roads, which he considered was a special branch of civil engineering, and that if Jonesborough was wise she would get a specialist for the particular work she was going to undertake, that is, he said, "get a good Water Works Engineer—right now—before you go any further, it will cost money, but it will be worth it."

The committee, had up to this time, thought it would not be neces-

sary to get the services of a civil engineer—at least thus early in the game.

The only source of supply—at least the natural source—would be of course Cedar Creek, which ran right through the village, and it should be a comparatively simple matter to buy and install the proper sized pump and lay the necessary mains through the several streets where water was wanted. The only objection which had been raised to the proposition of the new water works—was the expense—and at this time the employing of a Special Civil Engineer seemed a luxury which might be avoided, or delayed at least. They argued that the manufacturers of water pumps would gladly send on representatives experienced in this work who would without cost, advise the type and size of pump best adapted for their needs, and the same plan could be followed with the pipe laying. Public works contractors from the city would gladly come on and look over the ground and give suggestions on just what work should be done, and the cost of doing it. It would be time enough to employ an engineer when, or just before, the contracts were let. Any decision however on this question was to be deferred until after the committees contemplated visit to the Capitol City.

A few days later found the committee-men at the office of the Capitol City Water Bureau, and a little bit embarrassed they were too at their presumption in bothering the official head of this big department with their troubles. They soon discovered however that he was apparently no high-brow and he seemed quite interested in the proposed Jonesborough Water Works. He gave them the names of several good pump manufacturers and a list of the most reliable of the capitol city contractors. It would be necessary he said for the Committee to have an estimate of the gallons of water per day they would need. This would of course depend on many different factors. The number of people to be served, the area of the territory to be covered, the type and size of the manufacturing industries, etc., etc. The experience of other similarly situated villages would also be of great help in arriving at a solution. They should insist on a large enough pump and lay mains of sufficient capacity to take care of what he called the peak consumption load, plus the demand for ample fire protection. A duplicate pump he suggested, would be a mighty good thing to have, not only in case of a break-down of the main pump, but to take care of the increased growth of Jonesborough, which was bound to occur. They were fortunate, he continued when they

spoke of Cedar Creek, in having a supply so convenient. "Were there any riparian rights which would have to be purchased, or hadn't that been looked into yet?"

Jonesborough ought also to get an analysis of the creek water to see how it tested up for hardness, color, turbidity and other things which he knew water works men frequently encountered.

The State Board of Health should also be asked at once to pass on the Cedar Creek water as a proper source of public supply, as otherwise the committee might find out too late, that it was unfit and unsafe for domestic use. One other piece of information which the committee must surely obtain was the amount of flow available in the creek in the dry months, and through a series of several dry years. This information could be found, he said, by getting the Government Weather reports and topographical maps, and figuring up the rain-fall and probable run-off for the Cedar Creek Watershed. Possibly they would find some other source than Cedar Creek more advantageous. There were the Superintendent said, as they knew, several small lakes and ponds some miles back of Jonesborough—up in the hills—and one of them or a combination of two or three of the smaller ones, might make an ideal gravity water supply. The land in the vicinity was rough and uncultivated for the most part and would not be expensive if it had to be bought for protective purposes, and would lend itself perfectly to reforestation, the trees for which would be furnished by the State Forest Commission free of charge. While they would have to chlorinate this water, it might not be necessary to filter it, as would surely be the case with the Cedar Creek supply, and the money saved by eliminating the filtration plant and the pumping installation, would help pay the extra length of conduit and the land around the lakes.

During this informal talk, in which the Superintendent had casually and yet purposely brought up so many different points. The Jonesborough Committee had become more and more impressed with their own utter lack of knowledge of the problem before them.

It was not surprising then when the Chairman, voicing the opinion of all, spoke up as follows: "We don't know much about this water works business—can't we get some experienced man who isn't too expensive—and have him go over all these points and advise us how to act?" Sure thing said the Superintendent. "The demand for small public water supplies is increasing so rapidly that the designing and development of such water systems has become a very impor-

tant part of the civil engineer's work, and many of them are devoting almost their entire time to it." He then showed to the Committee, in one of the Water Works Journals, a list of Water Works Engineers, any one of whom would give valuable service to Jonesborough at a small percentage of the cost of their water works, and he stated that no one item of expense connected with its construction would give better returns.

A few evenings later, a second water works meeting was held in Jonesborough, and the Committee reported, to a packed house, that their investigations had led them to engage—subject to approval—Mr. Smith, a well known Water Works Engineer, who would speak to them on some of the initial problems of their proposed undertaking.

Engineer Smith, or "Our Engineer" as he was later called, explained that by law, in order to establish a public water supply, a petition for such—signed by a majority of the property owners in the proposed district, must be filed with the Town Board. This petition must describe the proposed water district and state the maximum amount to be expended in the construction of the water system. With the petition, there must be filed a map or plan, showing the source of supply and a description of any lands, streams or water courses to be acquired therefor, and the cost of constructing the proposed water works, including reservoirs, filters, mains, hydrants, etc. After the Town Board has approved the petition which has been posted or published the required number of days, the Water District will be formed by the Town Board appointing three taxpayers in the District as Water Commissioners. These Commissioners will then advertise for proposals for the construction of the works—as per the plans and specifications submitted. Previous to this action, the State, through its Water Supply Commission, must also approve of the project, principally for the purpose of seeing that all of the State Board of Health requirements are satisfied.

The funds for carrying on this work must be raised by the issue and sale of bonds which shall be a charge upon the town, and shall be collected from the property within the water district.

All of these legal steps, the Engineer explained, must be followed without question. They had been incorporated in the laws, not to restrict and discourage water works development, but rather to control and conserve, and make safe for all the people, all public water supplies in the State. The quality and quantity of domestic water, was not a matter that concerned just that community alone,

but was of moment to their neighbors and visitors and those merely passing through, and thus was of interest indirectly to the whole state, especially if there existed danger of serious contamination of the supply which might cause a wide-spread epidemic.

The Engineer stated that he had made no studies of the situation at Jonesborough, and did not consider himself employed as yet for this work, unless the meeting confirmed the action of its Committee, but he hoped that he had made it clear that they should employ *some* engineer, as such an enterprise most certainly needed one. Many states he added, expressly recited in their laws, that a competent engineer must draw up plans for any new public water supply.

Before the close of this meeting, a resolution was passed to petition the Town Board for a Water District, and a second resolution was carried, authorizing the employment of the speaker of the evening as Jonesborough's Consulting Engineer for the new water supply.

It is unnecessary to go into details concerning the preliminary studies and surveys which were made by the engineering force.

The decision finally submitted as to the best source for the new supply, was a great surprise. Although Cedar Creek or the small lakes and ponds could be made available, both were rejected as being inadequate for future needs, and involving too much treatment and expense to bring the water up to the required standards of quality for a domestic supply.

Jonesborough, the engineers report advised, should apply to and contract with, with Capitol City for the delivery, from *its* supply, of a sufficient quantity of water for all the domestic, manufacturing and fire protection needs of the new water district. Capitol City had a splendid and ample supply of water, and its water system was well managed. It had not been considered before as being of any aid to Jonesborough in this respect, both because it was some distance away and principally, because up to now it had always restricted its water consumers to its own citizens, in fact its charter so required.

The contention of the engineer was that the usual practice of each small town, village or water district, establishing its own distinct individual water supply, was wrong economically, and was becoming a menace to the water sources of the State, and sooner or later the State—if not the Federal Government—would put a stop to the practice and insist rather on a few large water districts, or supplies, each of these in turn to furnish water to all the adjacent communities.

This argument had been put to the Capitol City authorities. They were shown that their water supply, with additions to it which the city's large resources would permit from time to time, might well and with great justice, furnish a much wider territory, and many more people, than it now served, with advantage, both to itself and these new consumers. The City officials were finally convinced and now stood ready to make the necessary changes in their charter to permit such action.

Jonesborough was further away from Capitol City than some other small places, but if her application was granted, those others lying in the same general direction from the city would follow suit, and their coöperation would lessen the expense of the main conduit supply line.

There is not much more to tell. The plan as proposed was eventually carried through. Jonesborough, as well as many of the neighboring hamlets, now has a water supply, wholesome and adequate, without any of the worries of filters, pumps, watershed protection and the like. It buys its water from Capitol City by meter measurement, and in turn, sells it to the individual consumers. The village is 100 per cent metered, a condition that the designer of the system was particularly insistent about. The hydrants are of the same type as those in the big city, which is a great convenience when, as sometimes happens, the Capitol City Fire Department is called on to help out at a conflagration.

The bonds for financing the work were taken up by the very largest Security and Guaranty Company in the State; for at the suggestion of the engineer all the big companies had been invited to bid on the issue. This had brought Jonesborough to the attention of all the large banking institutions, and the village thus had a standing on the financial map which would be an advantage when other improvements came to be made and more money would have to be borrowed. As a fact, the water had hardly been turned into the new mains, when a demand for sewage disposal was raised. Tentative plans for a sewer system had originally been prepared to go along with the water system, but had been rejected.

How rare indeed is this admirable dual policy carried out, and yet as "inevitable as night the day" must a sewer follow the laying of a water main!

The expense to a small community of each of these improvements is of course large, and yet if designed and developed together, there

would be a great saving in the total cost, as well as innumerable other advantages. But the sewer is another story.

With the establishment of the Jonesborough water works—which was soon followed by others in the vicinity, the water bureau of Capitol City became the centre of a great Metropolitan Water District, and thus fulfilled the prophesy of the designer of Jonesborough's small plant. He had proved himself to be a practical engineer, and yet with a wonderful vision which could be made real.

Jonesborough's experience may not be really typical, and the plan she adopted cannot serve as a model for all others to follow, but it is hoped that her story may contain some encouragement and suggestions for the innumerable "four corners" and even larger suburban or rural groups which as yet are without public water supplies.

ANNOUNCEMENT OF PUBLICATION OF MANUAL OF WATER WORKS PRACTICE

The manuscript for the Manual of Water Works Practice will go to press by June 15 and the book should appear on the market by September 15, 1925. From present prospect it will be a text-book of approximately 600 printed pages. More than 300 members of the Association have collaborated through carefully coördinated group effect for the preparation of the subject matter. From the tentative table of contents printed below, it may be predicted that the volume should be of interest and aid to every branch of the water works industry. In order to bring the book within the reach of every reader, the selling price has been fixed at $5.00 per volume. In the advertising pages of this and succeeding issues of the JOURNAL, blanks will be found for advance orders of the Manual. It is important that these blanks be filled out at once so that the publisher may be advised of the probable edition required. The contents will be as follows:

INTRODUCTION

CHAPTER I

Development of modern water works—Elements of service rendered—Significance of water supply in disease incidence—Jurisdiction of state and federal authorities—International aspects of water pollution—Liability for water borne typhoid fever—Beautification of water works properties.

COLLECTION OF WATER

CHAPTER II

Allocation of streams—Compensation in money and in kind for water diversion—Watershed yields and required storage—Flood flows and the design of spillways and other structures.

CHAPTER III

Watershed protection—Industrial wastes.

CHAPTER IV

Ground water.

QUALITY OF WATER SUPPLY

Chapter V

Objectionable limits of constituents of water and their relation to practical problems—Standards of water quality.

TREATMENT OF WATER

Chapter VI

Self-purification of streams, lakes and reservoirs—Advantages of outlets at different levels for deep reservoirs—Algaecides.

Chapter VII

Chlorination, super-chlorination and dechlorination.

Chapter VIII

Aeration—Natural subsidence, coagulation and rapid sand filtration—Slow sand filtration—Double filtration—Covers for filtered water reservoirs.

Chapter IX

Removal of iron and manganese.

Chapter X

Water softening by lime and soda—Zeolite treatment.

Chapter XI

Ultra-violet ray treatment—Ozonization.

Chapter XII

Treatment of water with iodide for the prevention of goitre.

DISTRIBUTION OF WATER

Chapter XIII

Large mains—Distribution systems—Pressure tunnels—High pressure fire systems.

Chapter XIV

Sizes of filtered water reservoirs.

Chapter XV

Pumping station practice.

Chapter XVI

Services—Loss of head in corporation cocks and service pipes—Thawing frozen services.

Chapter XVII

Plumbing in relation to water supply.

Chapter XVIII

Corrosion—Electrolysis.

Chapter XIX

Water consumption and meterage—Industrial requirements—Water waste control.

FINANCING AND MANAGEMENT

Chapter XX

Adopted slides for meter rates—Data on water charges.

Chapter XXI

Price trends.

Chapter XXII

Valuation of water works—Reasonable provisions for depreciation.

Chapter XXIII

Financial requirements for betterments—Taxation—Legal limitations on bonded indebtedness—Water districts.

Chapter XXIV

Operating practice.

FIRE PROTECTION

Chapter XXV

Annual fire losses, United States and elsewhere.

Chapter XXVI

Charges for public and private fire protection services.

APPENDIX

Standard Forms, Procedures, Specifications and Contracts

Standard form for annual reports.
Mechanical analyses of filter sands and gravels.
Standard specifications for cast-iron pipe and special castings.
Standard specifications for valves.
Standard specifications for hydrants.
Standard specifications for meters.
Specifications for water works chemicals.
Specifications for pressure water filters.
Specifications for sanitary drinking fountains.
Standard form of construction contract.
Standard Schedule for Grading Cities and Towns: National Board of Fire Underwriters.

REPORT OF THE COMMITTEE ON CROSS CONNECTONS, OF THE NORTH CAROLINA SECTION[1]

The committee on cross connections begs to report as follows:

This section having adopted a resolution at the Newbern Convention condemning the so-called cross connections in no uncertain terms there remains but the determination of the methods that shall be adopted to accomplish the desired results.

Since the adoption of the said resolution by this Association there has been another outbreak of typhoid fever from which there were many deaths. This only makes it the more imperative that some definite action should be taken at once.

In examining the different conditions existing at the various plants in the state where there are cross connections, it has been made apparent to the committee that there can be no hard and fast rules laid down by which these connections can be eliminated. Each case will have to be treated according to the conditions that exist.

In general, it may be stated that in no case, whatever the treatment, shall it be possible to get contaminated water into the city system from the cross connection with a polluted supply. To arrive at a condition where it will be *impossible* to get the contaminated water into the city system the following general rules may be used as a guide.

1. Where there is a pump on the auxiliary supply there shall be no physical connection with the city system.

2. Where there is no pump on the auxiliary supply and the tank or tower is filled with the city water it will be permissible for a direct connection.

3. Where there is a pump and a tank on the auxiliary supply and there is a physical connection between the tank and the pump there can be no physical connection between the tank and the city supply.

4. Where there is an underground reservoir on the auxiliary supply that is filled with water from the city system there shall be no physical connection with the city system unless the undergound reservoir is water tight and contamination proof. That is, if there be a possibility of the reservoir from which

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[1] Presented before and approved by the North Carolina Section meeting, November 12, 1924.

the auxiliary pumps take water becoming polluted there shall be no physical connection with the city system either from the pump or the reservoir.

To accomplish the above suggested results, in case there is a tank connected with the auxiliary supply, the tank should have an over connection from the city system. That is, a connection of sufficient size going over the top of the tank to supply all the water that may be demanded. This connection must be above the over-flow line of the tank and the over-flow must be of sufficient size to take care of all the water that the auxiliary pumps can handle. In addition, the control valve on the city connection must be connected to the discharge pipe from the tower in such manner that the pressure in the discharge pipe shall govern the condition of the valve on the city connection. This control mechanism must be so arranged and calibrated that a drop of not less than 2 pounds pressure in the discharge line from the tower will cause the control valve to open and allow sufficient water to enter the tank to equalize the control mechanism, thereby keeping the tower full of water at all times.

Where there is an underground reservoir there shall be a float arrangement whereby the depth of water in the reservoir can be ascertained at all times. If necessary or desirable there may be a float valve attached to the end of the city connection that will automatically maintain the reservoir full of water. This should be from a separate connection, however, and should be metered. In case the demand from the reservoir is greater than this by-pass connection will afford the necessary enlargements shall be made. In case of demand from the reservoir for fire fighting the inlet valve from the city connection shall be operated by hand or by float arrangements. However, it is not desirable that the float arrangement shall be used on the main supply line. This will allow the use of water from the reservoir and will necessitate the metering of the main supply line. Where a consumer desires the use of water from the reservoir in small quantities a meter on the main line may not be justified.

In case the consumer desires to use small quantities of water from the tower there may be an auxiliary filling line of sufficient size with meter attached to cover this consumption. In no case should the use of water be allowed from the system unless there be a meter on the line. In case there is no possibility of using water from the fire system the meter may be dispensed with at the discretion of the governing body.

To further the adoption of such rules as shall eliminate the possibility of getting contaminated water into the city system the committee offers the following resolution:

Resolved: That the State Board of Health be requested to promulgate such rules and regulations as may be necessary to eliminate this danger to the citizens of the state of North Carolina.

Respectfully submitted,

M'KEAN MAFFITT, *Chairman*,
E. A. WIDENHOUSE,
C. E. RHYNE.

CONCRETE WELLS AT HOLLAND, MICHIGAN

By Roy B. Champion[1]

Holland is a city of 14,000 inhabitants, located on the shores of Black Lake, in Ottawa County, Michigan. Black Lake, unfortunately and slanderously so named, is 6 miles long and $\frac{1}{2}$ to $\frac{3}{4}$ mile wide, extending from the city to and connecting with Lake Michigan. The sailing distance from Holland to Chicago is 96 miles.

The water supply is derived from wells located in the sand and gravel drift which overlies the clay under the city. The source is rainfall. Developments have been made at three stations, namely, Nineteenth, Twenty-eighth and East Eighth Streets. The first two are located within the city and the third about $\frac{1}{2}$ mile east of the city limits. The three stations are equipped with centrifugal pumps driven by electric motors. Power is furnished by the Fifth Street station, owned and operated by the municipality.

While Holland has enjoyed a water supply excellent in quality, to provide it in sufficient quantity has always been a problem. The maximum demand for an hour or two has been all out of proportion to the average demand. For example, the average daily pumpage for 1923 was 1,057,000 gallons as compared with the maximum rate of 6,928,000 gallons. The entire output is metered.

In 1921, the possibility of additional water supply at the site of the present East Eighth Street station was accepted and ten 5- and 6-inch tubular wells were hastily installed on an average spacing of 90 feet and a depth of 40 feet. A temporary suction line was laid along the ground and a shelter house constructed for a pump borrowed from the Twenty-eighth Street station. All the haste was for the purpose of having the additional capacity, 1100 gallons per month, available for the summer load.

This work successfully completed, a 4-inch test well was sunk at one end of the line of wells to determine the depth of the sand and gravel. To our great surprise the well went to 120 feet before clay was reached. In all our prospecting elsewhere, during the previous

[1] Superintendent, Public Works, Holland, Michigan.

years, no such depth was encountered and 40 feet was deemed quite satisfactory.

To take full advantage of the situation, after a considerable investigation, agreement was entered into with the Kelly Well Company to build a concrete well 135 feet deep. This type of well was entirely new to us and the one in Holland, in fact, was the first to be constructed in Michigan.

The well consists of a plain concrete pipe, in sections, extending from the surface to the water-bearing stratum. Below the pipe and reaching to the final depth is the strainer portion of the well, also made of concrete and of the same diameter as the plain pipe. The inner diameter is 25 inches and the outer diameter is 32 inches.

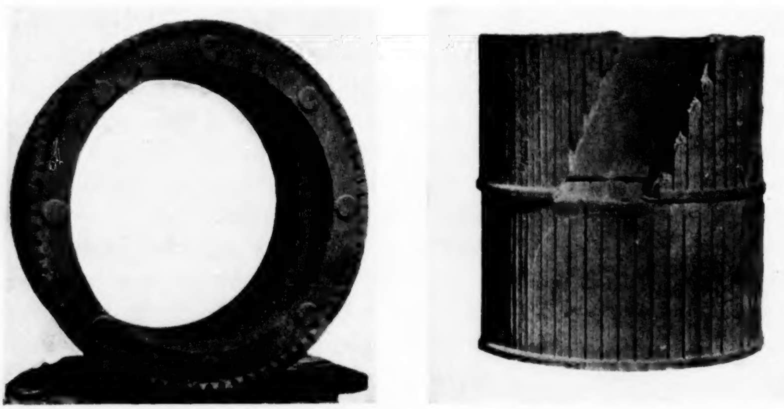

Fig. 1

The strainer sections are about $12\frac{1}{2}$ inches long and have vertical keystone shaped grooves cast in the outer surface. Water flows into the groove, thence to the bottom of the section and into the well. The sections are held apart approximately $\frac{3}{32}$ inch by means of bosses cast on the ends of the sections. The construction is more clearly shown in figure 1.

The operation of building the well consists of, first, driving a temporary steel casing the entire depth, removing the material from within with an orange peel bucket. Different diameters of steel casing are used depending upon the depth to be reached. The first section is driven down about 30 feet and there anchored. Within that section another is driven an additional 30 feet and still another section is let down within the second section and so on until the final depth is reached.

When the excavation is completed the first concrete block or plug is lowered to the bottom by means of four steel cables. Then the strainer sections and the plain pipe sections are lowered into place, being threaded over the four steel cables, which pass through vertical holes cast the full length of the sections.

When the concrete blocks are placed the annular space between the strainer sections and the steel casing, about 5 inches, is filled with selected washed gravel and the steel casing withdrawn. The back fill above the strainer section is made with clay.

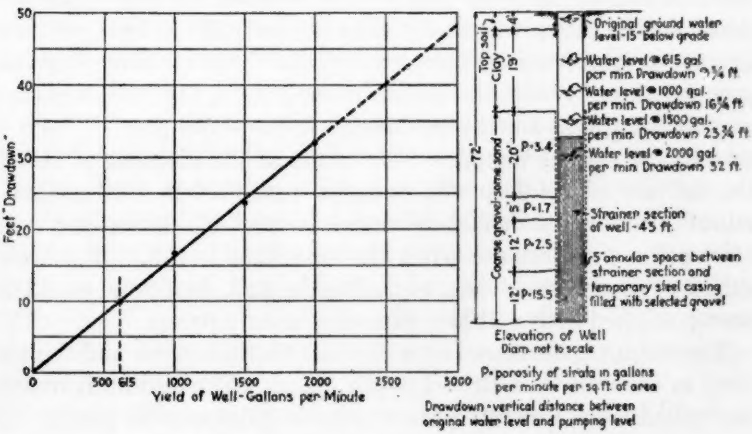

FIG. 2

During the construction of the well, a stratum of boulders was encountered at a depth of 72 feet which was not anticipated and the presence of which was not revealed by the 4-inch test well. Repeated efforts to penetrate the stratum were unavailing, notwithstanding the use of three or four moderate charges of dynamite. Finally, it was determined to build the well at that depth, 72 feet.

Upon completion of the well a twenty-four-hour test was made to determine the yield of the well. The rate of pumping throughout the test was maintained at 2000 gallons, measurement being made over a 4-foot weir. During the first eight hours the water level in the well lowered continually, but thereafter it remained constant. A higher rate could have been maintained had a larger motor been available to drive the pump.

Shorter length tests, at lesser rates of pumpage, are indicated by the curve in figure 2. During the 2000-gallons-per-minute test

the "draw down," or vertical distance between the original water level and the level when pumping, was 32 feet, the original or static level being 15 inches below grade.

In the development of the original tubular well system at this station, previously referred to, a 10-inch cast iron water main was laid from the station to the city limits. As this line was too small to take a larger output, the well was equipped with a deep well, three stage American Well Works centrifugal pump directly connected to a 100 horse power Westinghouse slip ring motor. The pump is supported by 40 feet of pipe beneath the base plate of the motor. The pump was designed to deliver 1220 gallons per minute against a total head of 210 feet. Water from all three stations is pumped directly into the distribution system, the excess pumpage over consumption flowing on through to the stand pipe. The condition of the service happens to be that, at the moment of starting, the delivery of the deep well pump is from 1400 to 1500 gallons per minute, but this immediately begins to trail off, during the run, to 1200 gallons per minute when the standpipe is full. If a main of sufficient capacity had been available, the well, doubtless, would have been equipped with a 2100-gallons-per-minute pump.

The output is measured by a Simplex Venturi meter and the water level in the well by a Bristol depth gauge. The station is remotely controlled from the Fifth Street station (the electric plant). The total output from the well during 1923 was 233,230,000 gallons at an average current consumption of 1.037 kilowatt-hours per thousand gallons.

The building over the well is of brick, 20 by 22 feet in plan and 18 feet 6 inches from the floor line to the top of the wall. The cost of the improvement was as follows:

Building	$2,820.53
Pumping equipment	6,271.67
Well	4,727.63
Total	$13,819.83

The soil penetrated was 4 feet of top soil, then 19 feet of clay and the remainder coarse gravel with some sand.

The success attendant upon the development of the well described led to their future use at the Twenty-eighth Street station. This plant was constructed in 1916 and obtained its water from a line of twenty-eight 5- and 6-inch tubular wells spaced 90 to 100 feet apart.

These wells averaged about 30 feet in depth and were located in a very fine sand formation. The yield was excellent in quality and sufficed for one of the two 1100-gallons-per-minute pumps. In 1921, however, the yield began to fall off and finally failed altogether in 1923. Efforts to clean the brass screens by backblowing with air availed us nothing and finally it was determined to substitute some concrete wells for the tubular wells. Seven concrete wells were constructed, all 28 feet deep, except one which is 30 feet deep. The inner diameters are 18 inches and steel casing was used which permitted a gravel wall 11 inches thick around the strainer sections of the well which were six in number. All the joints of the plain casing were sealed with "Pipe Seal," a product used for making the joints of earthenware sewer pipe. This was accomplished by placing a tin form around the top o[illegible]sing section before it was lowered, it being of such height that, when the next section was lowered to place, the form stood about 3 inches above and below the joint. With the steel casing pointing into clay it was an easy matter to pump the water out. Then a man was let down on the outside of the concrete to the lowest joint, about 20 feet below grade, to pour the form full of "Pipe Seal," making a thickness of about $\frac{3}{4}$ inch thick. This method effectually sealed the joints in question and at comparatively little expense.

The seven wells were placed at varying distances apart, no two being closer together than 350 feet. On individual tests, the capacities ranged from 270 gallons to 470 gallons per minute. Accurate determinations of the "drawn down" were not made on the individual tests. The tests were continued in each case long enough to clear the well of sand. On extreme cases this required thirty-six hours.

The seven wells have been pumped to 1500 gallons per minute and will probably yield better than that for short periods. The "draw down" when the wells were being pumped together at an average rate of 150 gallons per minute per well was 7 feet 3 inches.

The cost of this improvement was as follows:

Concrete wells	$4,844.16
Sealing joints with "pipe seal"	247.31
Valve chambers	440.28
Initial pumping and cleaning	595.02
Drop pipes, valves and connection to existing suction lines	468.46
Miscellaneous	46.66
Total	$6,641.89

The seven wells, in 1923, yielded 43,747,200 gallons at an average current consumption of 1.314 kilowatt hours per thousand gallons. This station is used only intermittently as needed.

The features of this type of well construction which appealed to the writer are: (1) when necessary or desirable, strata of soil may be blanked off at will by merely substituting one or more plain casings between strainer sections; (2) the condition of soil penetrated is not disturbed in the least and there is satisfaction in the positive knowledge that the wall of gravel is where it ought to be; (3) filtration of all the water the stratum will yield is practically assured and (4) long life may be confidently expected.

The wells described were designed and built by the Kelly Well Company of Grand Island, Nebraska and Kalamazoo, Michigan.

DUBUQUE'S AIR LIFT PUMPING PLANT[1]

By J. W. McEvoy[2]

Early in 1922 it became apparent to the city officials of Dubuque that steps must be taken to increase the capacity of the water works pumping station. The engineering firm of Mead & Seastone of Madison, Wisconsin were engaged and requested to make a survey and report with recommendations as to the necessary changes and additions.

At this time the water works consisted of two sources of supply; a group of shallow sand wells averaging 6 or 12 inches in diameter and about 100 feet in depth were all connected to the suction of a steam driven pump and the water was discharged into a surface reservoir of 500,000 gallons capacity. The suction of this pump was also connected to a large sand well 8 feet in diameter. The daily capacity of this sytem was 1,570,000 gallons per day. The second source of supply was from four artesian wells averaging from 1300 to 1450 feet in depth. These wells had a natural flow of 1,016,712 gallons and were also arranged so that they could be pumped by suction from a motor driven centrifugal pump. When pumped in this manner the total delivery was 1,779,840 g.p.d. This gives a total pumpage from the complete system of 3,349,840 g.p.d. A high duty steam pump was used to take the water from the surface reservoir to a large seven and one-half million gallon reservoir located on a bluff at a point higher than most of the service demand. A standpipe is located at a still higher point to serve the part of the population above the large reservoir.

In determining upon the source of water which should be used for the new plant, there were three different sources considered: (1) The Mississippi River (with filtration); (2) The shallow sand wells; (3) The deep artesian wells about 1500 feet deep into St. Peter and Potsdam sandstone.

Serious consideration was given to a filtered supply from the Mississippi River due to the fact that this source would provide

[1] Presented before the Iowa Section meeting, November 8, 1924.

[2] Superintendent, Water Works, Dubuque, Iowa.

ample supply for all time. The cost of a plant to develop this river supply would be much greater in initial investment, cost of operation and maintenance than that for a ground water supply.

The second source of supply and the one from which a large part of the water is now obtained is from the sand stratum located at a depth of about 100 feet below the surface. The extent of this stratum is somewhat limited, which necessitates the placing of the wells fairly close together. Tests conducted over a period of years has shown that the amount of water pumped from the sand wells is constantly decreasing. The most serious problem encountered in developing a supply from this source is that of mutual interference of the wells. Tests showed that, when pumping all the wells at one time, the total yield was only 78.8 per cent of the sum of the individual capacities. It is a well known fact that the lower the water level is dropped in a well, the greater becomes the circle of influence towards interference. The lowering of this water level to the top of the water bearing stratum, which would be necessary in order to obtain a sufficient supply, would cause considerable interference with any other well which might be put down in this sand. This interference makes the development and securing of ample supply from this source from large wells doubtful. The static level of the water in this sand stratum is 15 feet below the surface, while the bottom of the sand layer is 100 feet, so that the available drawdown is 85 feet. With the large diameter open type well it would be practically impossible to lower the water closer than 20 feet from the bottom of the well. Tests conducted showed that the maximum quantity which could be obtained with this drawdown would be about 4,970,000 gallons per day from this shallow sand layer. Due to the interference, the limited extent of the sand stratum and the lack of definite information as to the amount of water available from this source, the idea of developing this supply was also abandoned.

Artesian wells have been in use in the City of Dubuque for many years and have always been a constant and reliable source of supply. When the first wells were drilled the static level was about 100 feet above the ground surface. The static level of the artesian wells at the water works is now 23 feet above the surface of the ground. It is a well established fact that there is a considerable drop in static head on an artesian basin when wells are first drilled. A portion of the static head is consumed in creating the flow for the new wells

and this decrease continues in a certain locality as long as new wells are drilled. As the number of wells increases, the lowering of the static head decreases so that at the present time, with a large number of wells in operation, the drilling of a new well has very little effect on the wells already in operation. The loss in head of a well which becomes evident with age is due to developments of defects in the well casing, gradual filling up of the pores of the sandstone, due to the drifting of fine material to the well, and growth of low forms of plant life in the pores of the rock. The losses may be corrected by replacing the defective casing and by pumping into the well and reversing the flow or reaming the well, or shooting with dynamite at the water strata. Tests have proved that the falling off in capacity of artesian wells is slight, provided the wells are maintained properly.

The four artesian wells which were already in use at the plant were tested and it was found that the yield was 28.7 gallons per minute per foot of drawdown. Practice has demonstrated that when the total drawdown of an artesian well is about 10 per cent of the depth of the well, the increase in capacity is proportional to the drawdown. Hence by lowering the water level to a depth of 100 feet below the ground surface a total capacity of 5,100,000 g.p.d. or as much more as could be obtained from the strata could be pumped. It was deemed advisable to figure on one additional well in order to give a total capacity of over 6,000,000 g.p.d. from the artesian well system.

The initial cost of a plant to develop either the shallow or the artesian well supply would be practically equal, while the cost of operation and maintenance would be lower with the artesian well system. The artesian system would have a capacity of over 1,000,000 g.p.d. in excess of the shallow wells. The supply from the artesian wells is a known quantity, while it is uncertain how much water could really be obtained from the shallow sand strata. Due to the above reasons it was decided to develop the artesian supply as a permanent source of water. It then remained to adopt a method of pumping which would prove most economical over a period of years and yet be reliable and satisfactory.

In pumping water from deep wells any method of pumping is bound to be relatively inefficient. Either one of two systems were available; the air lift method or motor driven deep well turbines. Careful comparisons of these two methods were made in order to choose the one which seemed most advisable. The actual pumping efficiency of the deep well turbine is slightly better than that of

the air lift system, but it was found that, by the use of the proper machinery, the total cost of raising water by means of the air lift was less than with deep well pumps, taking the overall efficiency from wire to water and making due allowances for maintenance and repair expenses. The simplicity and reliability of the air lift, particularly its freedom from moving parts below the ground, requiring oiling and subject to wear, make it a more satisfactory method of pumping than centrifugal deep well pumps with high speed runners and long shafts located at inaccessible places deep in the wells. With the air lift system all the moving parts are located in the power house where they can be under constant inspection.

The advantages of the air lift system over the deep well pump are summed up as follows: (1) The air lift is dependable, simple and durable and will deliver water year in and year out with small chance of interruption of service by breakdown of the plant; (2) modern air lift practice secures high pumping efficiency and this efficiency is maintained for long periods of time; whereas with the wear on a deep well turbine, the efficiency is highest at the start and is continually decreasing; (3) more water can be obtained from a given well by the air lift than with any other method. With air the wells can be backblowed and cleaned, in this way keeping them up to their original capacity and even increasing the first delivery due to opening up the pores in the sandstone; (4) the air lift is more flexible. Water may be pumped at widely varying rates without materially lowering the efficiency. A change in pumping level will not change the efficiency. A group of wells may be operated from a central point, which means minimum attention to the machinery.

The principal objections to the use of the deep well turbine are: (1) the rapid moving parts which are located in the well require constant replacing, which is a costly operation; (2) sand causing rapid wearing of parts, while it has no effect on the air lift; (3) the deep well turbine cannot efficiently follow the water to a lower level and will not pump efficiently at varying capacities. After comparing the two systems it was decided by the engineers to adopt the air lift system for pumping the artesian wells.

The city was able to obtain a low power rate, in view of the fact that all the pumping, except in emergencies, would be done in the off-peak periods for the local power company, or from early evening until late morning. The average daily consumption of water is about 3,300,000 gallons. Due to the elevations in the city it was possible

to have a high duty reservoir of 7,500,000 gallons capacity which supplies the largest part of the demand. Because of this low power rate it was by far most economical to install electrically operated equipment.

A new addition to the present water works was made and in it were housed the air compressors and centrifugal service pump. The contract for installing the air lift system was let to the Sullivan Machinery Company, of Chicago. The compressor plant consists of two units of the Sullivan Class WJ-4, size 20 x 12 x 14 inches, belt driven compressors, each having a capacity of 2428 cubic feet per minute. These machines are operated by 400 hp. synchronous motors. The compressors discharge into a large air receiver and from this the distribution pipes lead to the five wells. Each well is equipped with a Sullivan Central type 8 x 2½ inches air lift footpiece with Sullivan Cyclone Booster. The boosters are placed in concrete pits which are entirely below the ground surface. They are used to elevate the water to the surface reservoir which is at a higher elevation than the well tops. The discharge from all five wells goes over a permanent weir before it enters the reservoir. A large motor driven, direct connected centrifugal pump is used at this plant to force the water into the high duty reservoir.

All machinery was installed on a performance guarantee basis and early in September the test of the air lift system was made by the engineers. The results of this test showed a total pumpage of 6,475,680 gallons per day pumped, with an average total lift of 128 feet. Under these conditions the guaranteed air consumption was 0.490 cubic foot per gallon of water. The test showed an actual consumption of only 0.442 cubic foot or the air consumed was 11 per cent less than the guarantee. The total horse power required was 412 while the guarantee was 428.

In addition to the improvements at the main pumping station a small booster station is being constructed near the same elevation as the high duty reservoir. Two motor driven centrifugal pumps, automatically controlled, are used to pump the water to the standpipe which supplies the highest portions of the city.

With the completion of these improvements the City of Dubuque now has a total pumping capacity of about six and one-half million gallons per day from the artesian system and in addition has a supply of one and one-half million gallons from the shallow sand wells, making a total capacity of about eight million gallons per day with

a daily consumption averaging about three million gallons. With the two days supply high duty reservoir, adequate service mains and a reliable pumping equipment the City of Dubuque can be fairly well assured of a reliable and constant supply of water for some years to come.

THE MANUFACTURE OF HIGH SILICON IRONS AND THEIR APPLICATION BY THE WATER WORKS ENGINEER[1]

By W. H. Scott[2]

Ordinary cast iron or, more strictly speaking, commercial gray iron from a cupola furnace will run from 1 to 3.5 per cent silicon, depending on the characteristics desired in the casting. The specifications are greatly influenced, of course, by the size and shape of the casting and the purpose for which it is to be used.

As the amount of silicon is increased in cast iron, the physical and chemical properties vary markedly, but there is little indication of acid-proof qualities until the silicon approaches 13 per cent, and at about 14 per cent this quality shows a very sharp increase. It has been found in actual practice that a high silicon iron from 14.25 to 14.50 per cent silicon is the most practical and useful.

A pure silicide of iron contains about 20 per cent silicon, but owing to its extreme hardness and low strength such a metal has little commercial application, and even when the silicon content is between 14 and 15 per cent the metal is too hard to be machined by ordinary cutting tools, but must be finished by grinding. However, pipe may be cut in the same manner as cast iron soil pipe, and the material can be welded with a gas torch. As a general rule, a silicon iron that can be machined with a cutting tool is not satisfactory for severe corrosive work.

A more descriptive name for these alloys would be "iron silicides," as they probably consist of alloys of iron silicide and iron. Any elements outside of iron and silicon have a marked effect in diminishing the resistance to corrosion.

In general, resistance to corrosion increases with the silicon content. Above 15 per cent the increased resistance of the alloy does not justify the higher cost of manufacture.

Iron silicides, to give satisfactory results, must be manufactured

[1] Presented before the North Carolina Section meeting, November 12, 1924.

[2] Duriron Company, Inc., Dayton, Ohio

under the most careful metallurgical control, as slight variations in composition, pouring temperature, or cooling rate will have a marked effect on the acid resisting qualities.

Where severe corrosive conditions are to be encountered, a minimum silicon content of 14.25 per cent and a maximum carbon content of 0.80 should be insisted upon. A higher graphitic content has been found quite objectionable, as it not only lowers resistance of the metal to corrosion, but is apt to segregate and form pockets of pure graphite.

A lower silicon content, particularly if accompanied by an increase in carbon, will result in a rate of corrosion several hundred times as great as would be the case if the specifications mentioned were met.

Uniformity of composition is a primary requisite for a satisfactory corrosion resisting iron, as it is evident that a casting is no more acid-proof than its weakest spot. Slag inclusions and carbon segregations would be fatal under severe corrosive conditions. In order to produce such a product that can be guaranteed as to uniformity of composition and of homogeneous structure, ordinary foundry practice and equipment has been found inadequate.

I should like to make clear that a high silicon iron is not a mixture of iron and silica, nor is it in any way a product like glass. Glass is a silicate made from silica which bears the same relation to the metal silicon as does iron rust to the metal iron. From a physical standpoint it is a corrosion-proof iron—weight about the same as cast iron, strength about two-thirds and with about three times the expansion of cast iron.

In the manufacture of these corrosion resisting irons the best grade raw materials must be used. Two meltings are necessary, the first to produce pig of the approximate analysis desired, and the second melting to bring up to the exact analysis by doctoring with a 50 per cent electric furnace ferro-silicon. During the last melting, oxidation of the silicon is prevented by using a special flux which protects the molten metal from direct contact with the flame and hot gases.

The molding practice and core work are very different from gray iron work. Chaplets can not be used and cores must be supported by entirely new methods.

Castings are finished by grinding with carborundum wheels, and the art has progressed to the point where practically any size casting can be made and any piece of apparatus possible in gray iron can be

duplicated in a corrosion-proof iron, with very slight changes, and machined to tolerances as close as plus or minus $\frac{2}{1000}$ of an inch.

Of general interest to the water works engineer is the use of this corrosion resisting material for handling alum and chlorine—steam jets for dissolving alum, pumps, ejectors, cocks, valves, pipe and fittings, both flanged and bell and spigot. Special apparatus for handling this alum solution makes a most practical and wellnigh everlasting installation.

I have yet to learn of a high silicon iron installation, where the material was of high grade, that has shown evidence of failure or that gave trouble from clogging.

The material is in general use in chemical plants manufacturing alum and in pulp and paper mills where great quantities of alum are handled daily.

These iron silicon alloys will stand hydrochloric acid better than any other commercial metal alloy and are wellnigh perfectly resistant to dry chlorine gas.

By connecting an ejector to the chlorine supply line and using water instead of steam in the jet, a column of mercury will indicate exactly the amount of chlorine being fed. Other applications will suggest themselves to the water works engineer where corrosion of gray iron, steel or bronze is a condition. In fact, a standard high silicon-iron material may be expected to give most satisfactory service under the most severe corrosive conditions to be met in a water works plant, and its use for water mains in places where acid soils destroy ordinary material is limited only by its higher first cost.

IMPORTANT PROBLEMS OF FILTER PLANT OPERATION[1]

By C. W. Smedberg[2]

Problems of plant operation are so numerous and varied in character as to prohibit a discussion of them all within the scope of a single paper. It will be necessary to confine ourselves to the more important problems and to these only briefly.

Problems of plant operation originate as a result of conditions and influences not alone within the plant itself, but also as a result of conditions and factors at the source of supply. Topographical and geological features of the watershed, together with influences contributed by sewage and industrial wastes, affect the character and nature of a water in producing varying amounts and degrees of turbidity, color, odors, taste, alkalinity, carbon dioxide, bacteria, organic matter and microörganisms, all of which influence methods of treatment and subsequent plant problems. The variation in the character and nature of a water as a result of these influences produces a plant problem of great importance, namely, the accurate control of chemicals and basin treatment, important in their bearing on operating costs and quality of plant effluent.

Chemical control may be defined as the determination of the proper minimum amounts and proportions of chemicals to meet the fluctuating character and quantity of water passing through the plant to secure complete reaction between chemical and water with maximum efficiency of coagulation and subsequent basin treatment, and the elimination of objectionable and undesirable qualities in the plant effluents.

Proper chemical control to secure maximum efficiency and results in treatment necessitates as a first requisite that means be provided for the accurate determination of the quantity of water passing through the plant. Various means have been developed from time to time to meet this demand. The more commonly used is the

[1]Presented before the North Carolina Section meeting, November 12, 1924.

[2]Water Department, Greensboro, N. C.

venturi tube inserted in the line entering the plant in conjunction with an indicating device.

The quantity of water passing through the plant being accurately known, the next important phase of the chemical control problem involves the selection of chemical equipment for the accurate addition of the chemicals to the water. The older and better known method of applying chemicals is in solution form of a known strength by the use of an orifice, the quantity being regulated and proportioned to the flow of water by varying the size of the orifice. The more recent development is the dry feed machine, the quantity of chemical being regulated and proportioned by varying either the speed of the machine or the width and depth of the chemical stream or ribbon. The selection of the proper equipment to suit the character of the water is of importance in its influence on the plant layout and results. Solution feed requires more equipment and storage tanks than the dry feed. The preference of either method as to accuracy is open to question in view of the improvements made in both during the past few years. The quantity of water known and suitable chemical feed equipment provided, the third phase involves the determination of the minimum amounts and proportions to suit the character of the water.

Most plant operators have had brought to their attention the fact at one time or other, that improper coagulation may result from an under, as well as over dose of chemicals. They have also observed that at a point lying between these two extremes, good coagulation results and have no doubt appreciated the saving in time, chemicals, and increased plant efficiency, if means were available for the quick and accurate determination of this point of good coagulation.

The application of the hydrogen ion concentration test to water filtration plants furnishes this means and marks a step forward in solution of chemical control problems.

By the application of this test to water we find that maximum coagulation takes place only within a narrow zone, outside of which, regardless of increase or decrease in chemicals, coagulation is retarded or suppressed entirely. Adjustment of the amounts of chemicals to produce optimum pH conditions results in the most efficient use of the chemicals for maximum coagulation.

Hatfield has shown, as a result of experiments conducted with water at the Highland Park Michigan Plant, that coagulation under optimum conditions eliminates practically all solvent action on the floc of the basins and the appearance of aluminum in the plant efflu-

ent. Should subsequent investigations confirm his observations with waters of various types, means will be available for controlling and solving the problems involving after-precipitation and corrosion.

The application of the hydrogen ion concentration test to plant routine enables not only a more economic and efficient proportioning of chemicals to suit the variable character of a water, but assists in pointing the way to further economies, as was the case at Baltimore in the adoption of the use of an acid in conjunction with alum as a coagulant, with appreciable saving in the amount of alum. It is unfortunate, however that optimum coagulation conditions are in the range most favorable to corrosion.

Another factor of importance in chemical control involves the securing of intimate contact and agitation of chemicals and water for best results. This has led to the development of the close baffled mixing basin with which the newer plants are provided.

This particular phase of the problem involves the determination of factors dealing with proper mixing velocities and periods of contact to secure maximum coagulation. Results of plant operation and laboratory tests on various types of water indicate that a short period of contact of 15 to 30 minutes is far more effective than longer periods and that the velocity of mix rarely need exceed 0.6 feet per second for maximum results. Long periods of contact at high velocity tend to break up the floc structure with resultant loss in efficiency of coagulation. Observations made at the Greensboro plant confirm these results in that, with optimum pH conditions of 6.2 to 6.4 a heavy well-defined floc is formed with a period of contact of 15 to 18 minutes, and velocities ranging from 0.45 to 0.55 feet per second. Further contact or higher velocities tend to break up this floc. These observations lead to a criticism of mixing basins as usually designed in not permitting sufficient flexibility in operation to meet the varying character of the water.

Waters coagulated under optimum conditions settle more readily and require smaller basin capacities. The problems of proper sedimentation involve proper inlet and distribution of the water across the width of the basin with the least possible injury to the floc and full utilization of the basin, together with proper periods of retention and velocities of flow to suit the character of the water. Plant results indicate that a straight line flow basin offers maximum efficiency of sedimentation in the lower velocities attainable and the elimination of objectionable convection currents, with attendant vertical velocities. Lack of flexibility in basin operation introduces difficul-

ties on account of the inability in many instances to vary velocities of flow and retention periods to meet the requirements of a variable water.

Filter operation involves problems of maintaining proper amounts of coagulant on the filter surface, proper maintenance of the sand bed, rate of filtration and of washing. Of these, washing, the most important problem of filter operation, has been given more study than any other phase. It is without doubt the most improperly used and abused. Proper washing of a filter unit is important in the maintenance of a filter at highest efficiency and usefulness as a filtering medium and in the prevention of the formation of impermeable areas, mud balls, uneven filtering with high rates of flow and deterioration of effluent quality.

The so called "high velocity" method of washing has superseded the combined air and water wash almost entirely, as it requires less equipment and is more effective in results. The high velocity method of wash depends for its effectiveness on even distribution and maintenance of a velocity sufficient to raise and agitate the entire sand bed, at the same time cleansing the sand grains by the scrubbing action of the water in its upward flow. The method, therefore, involves maintenance of proper velocities, length of wash and distance of waste troughs above sand bed to secure maximum effect. A prime requisite, therefore, for proper wash is the provision of means for accurately checking the amount of water being applied and the velocity, by the insertion in the wash water main of a meter with a suitable indicating device. This feature, for reasons of economy, has been eliminated in plant construction and is no doubt the cause in every case of improper washing and resultant filter problems. The rate of application of wash water probably need not exceed 15 gallons per minute to the square foot of filter area or a vertical rise of 24 inches per minute, with waste troughs 24 to 25 inches above the sand surface. The length of wash required is governed to a great extent by the condition of the unit prior to washing, but in routine operation rarely need exceed 5 to 10 minutes. Too long a period of washing tends to remove all the coagulant, a partial retention of which is necessary to form a thin mat on the sand surface when placing the unit lock into service.

The proper time of washing a unit is of as much importance as the proper washing, as a delay in so doing develops a partial vacuum in the bed which will break through at some point and allow improperly filtered water to pass through.

EXPERIENCE WITH CHEMICAL DRY FEEDERS[1]

By C. E. Rhyne[2]

When Gastonia built its new filter plant several years ago it did not build a chemical house but converted a part of the old filter plant building into one. In doing so we experienced trouble in several different ways. We did not have room above the dry feed machines to erect the storage hoppers furnished with the machines and had to build instead a hopper holding around a half bushel. Due to the location of the chemical house and the Venturi meter tubes, we had to build about 200 feet of chemical feed line to connect with the incoming raw water line. This line was built of class B 4-inch cast iron bell and spigot pipe using 4-inch tees under each feeder machine. We intended to use raw water to dissolve the chemical, but due to the present floor elevation we were unable to do so and had to use filtered water instead, which requires around 18,000 gallons per day of twenty-four hours. This service is metered.

The dry feed machines are of the screw feed type employing an adjustable pawl and ratchet for varying the quantity fed, the feed screw passing through an orifice or a cutting plate directly under a sheet metal storage hopper. The rotation of the screw is intermittent, that is, it varies in accordance with the amount of teeth engaged on the ratchet by the pawl. A stripper rotating at a much higher speed picks up the chemicals as discharged from the screw and feeds these in a constant stream into the dissolving hopper. In addition to the pawl and ratchet rate varying mechanism, there are also furnished gears for providing two speeds, the minimum speed being used for low feeds and the maximum speed for high rates of feed.

The machines are in duplicate and designed to feed both alum or lime. They are operated by a half horse power electric motor, the speed of which is reduced by a fully encased worm gear, this worm gear being in turn connected to the two speed gears driving the feed screw. The entire mechanism of these machines is mounted on a

[1]Presented before the North Carolina Section meeting, November 12. 1924.

[2]Superintendent, Water and Light, Gastonia, N. C.

suitable cast iron bed plate. The minimum capacity of these machines is 25 pounds and the maximum capacity 2500 pounds per day each. These machines were furnished by the Roberts Filter Manufacturing Company.

All chemicals are bought in barrels and elevated to the feed platform as needed by a chain hoist. The small hoppers on the machines are filled direct from the barrels by using a small grocer's scoop. With a plant of our size, using from 125 to 200 pounds of chemicals per day, we get better results by using the smaller hoppers, for, with the large hoppers holding around two days supply, the operators would neglect attending the machines as they should. Feeder machines are like any other piece of machinery, they require a certain amount of care and attention to give service.

We experienced some trouble with these machines at first in having the feed screw race and empty the machine in a short time, giving the water an overdose of chemical which caused serious trouble. After a close check on these machines we found that this was caused by the chemical forming an arch or hollowing out around the feed screw, releasing the pressure on it and causing it to revolve at the same rate of speed as the stripper. In these machines the feed screw is mounted on the stripper shaft in the same manner as a tight and loose pulley are mounted and when the back pressure or friction caused by the chemical is removed the feed screw will revolve at the same rate of speed as the stripper. We overcome this trouble by giving the machines closer attention and keeping the chemical pushed down firmly around the feed screw with a small tamp made from a broom handle.

After two and one-half years service we had to replace one of the 4-inch cast iron tees in our solution feed line that was eaten up by the solution. This tee was directly under one of the dry feed machines and caught the solution from the dissolving hopper. The solution had a drop of 12 inches from the hopper to the bottom of the tee and where this occurred a hole 3 inches in diameter was eaten through. We made a careful inspection of the line and found it in good condition.

The dry feed methods are superior to the solution feed as they are cleaner, require less labor and time to operate and less worry of clogged solution lines, which always occur at night. With the various makes and types of dry feed machines now on the market, I feel sure that the solution feed method will soon be a thing of the past in all sizes of filter plants.

REPORT OF COMMITTEE 12, ON TESTING OF WATER WORKS MATERIALS AND SUPPLIES

Committee 12 herewith submits its report for 1925. In accordance with the request of Standardization Council the report has been arranged with an idea of its substance being conveniently incorporated, in so far as desired, in the forthcoming Manual.[1]

The Committee has devoted its endeavors to improving specifications for chemicals used in the treatment of water and in extending its descriptive lists of Standard Specifications issued by the American Engineering Standards Committee, American Society for Testing Materials, Federal Specifications Board, etc. Methods of chemical analysis for chemicals used in the treatment of water have been added.

The material for this report has been the work of the Committee, but there has not been time to secure the complete criticism of the whole Committee as to the arrangement and wording.

Respectfully submitted,

THOS. H. WIGGIN, *Chairman*,
W. R. CONARD,
A. V. GRAF,
C. P. HOOVER,
F. A. MCINNES,
RICHARD MERRIMAN,
THADDEUS MERRIMAN,
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METHODS OF ANALYSIS FOR CHEMICALS USED IN THE TREATMENT OF WATER

SULFATE OF ALUMINUM

1. Insoluble Matter.

(a) Dissolve 5 grams of the sample in 100 cc. of boiling distilled water and boil for 10 minutes.

(b) Filter through a weighed Gooch crucible and wash the insoluble matter with boiling distilled water thoroughly.

[1] The sections of this report to be used in the forthcoming Manual are not here reproduced.—*Editor*.

(c) Dry at 100°C., cool and weigh. Report the percentage of insoluble material.

2. Oxides of Iron and Aluminum.

(a) Dilute the filtrate from the determination of insoluble matter to 500 cc. with water free from carbon dioxide and thoroughly mix the solution.

(b) Transfer 50 cc. of the solution to a 250 cc. beaker, add about 150 cc. of water and 5 cc. of concentrated hydrochloric acid and 1 cc. of nitric acid and heat to boiling.

(c) Add ammonium hydroxide in slight excess; when the solution has been almost neutralized it is convenient to add a drop of methyl orange indicator and then to add about 0.5 cc. of ammonium hydroxide after the solution is neutral to the indicator.

(d) Digest at about 100°C. for a few minutes and filter.

(Note: Some analysts prefer to wash this gelatinous precipitate with hot water by decantation and some to wash it evenly distributed over the surface of a filter paper; either method may be used. It is difficult to free it completely from impurities and it is not necessary to do so unless unusual quantities of calcium, magnesium, sodium or potassium are present. While the precipitate is being washed do not allow it to become dry, as it then packs and cannot be washed clean.)

(e) After most of the water has drained, drying the filter may be hastened by placing it on a sheet of blotting paper. If much iron is present, completely dry the precipitate, remove it from the paper and ignite the paper separately.

(f) Finally, blast the precipitate, with free access of air to the crucible, for 5 or 10 minutes, cool and weigh as oxides of iron and aluminum. $(Fe_2O_3 + Al_2O_3) \times 2 =$ percentage.

(g) Subtract the content of total iron, expressed as ferric oxide (Fe_2O_3), from the weight of the combined oxides and report the difference as aluminium oxide (Al_2O_3), in percentage.

3. Total Iron (Fe_2O_3).

(a) Ten grams of the sample are dissolved in 250 cc. of boiling water (if the insoluble matter is high this should be filtered off).

(b) Enough N/10 $KMnO_4$ is added to make the solution pink. The solution is allowed to stand for 10 minutes and then about 30 cc. of 1:1 solution of H_2SO_4 and 3 grams of C.P. zinc are added and kept in a warm place until the zinc is practically all dissolved.

(c) The solution is filtered as rapidly as possible and immediately titrated with N/10 $KMnO_4$. The number of cubic centimeters $KMnO_4$ used, multiplied by $0.080 \times$ percentage of Fe_2O_3. A blank should be run of the reagents used.

4. FeO and Fe_2O_3.

If it is desired to determine the FeO and Fe_2O_3, the FeO may be determined by titrating the clear solution from a 10 gram sample with N/10 $KMnO_4$. The Fe_2O_3 is determined by the difference.

5. Basicity Ratio.

(a) Transfer 50 cc. of the filtrate from the determination of insoluble matter to a 2000 cc. casserole and dilute it to 100 cc.

(b) Boil the solution and titrate it at *boiling* temperature with N/5 sodium hydroxide in presence of phenolphthalein indicator. The percentage of acidity

in equivalent of sulfuric acid is equal to the number of cubic centimeters of sodium hydroxide used multiplied by 1.9616. In this titration, iron and aluminum are precipitated as hydroxides and any free acid is neutralized.

(c) Calculate the percentage of sulfuric acid equivalent to the determined percentages of aluminium oxide, ferric oxide and ferrous oxide by the following formula:

$$2.88\ Al_2O_3 + 1.83\ Fe_2O_3 \text{ and } + 1.36\ FeO \text{ if determined}$$

If this percentage of acid equivalent is less than that found by titration report the difference as percentage of free acid. If the percentage of acid equivalent is greater than that found by titration the difference divided by 2.88 is the percentage equivalent to the excess of aluminum oxide present. Divide this excess by the percentage of total aluminum oxide and report the quotient as the basicity ratio.

BAUXITE

Tri-acid Method of Analysis of Bauxite

Acid Mixture.

$$1200 \text{ cc. } H_2SO_4 \text{ 25 per cent by volume } \begin{cases} 900 \text{ cc. water} \\ 300 \text{ cc. 66°Be Acid} \end{cases}$$

600 cc. HCl

200 cc. HNO_3.

1. Silica.

(a) Place in a 4-inch evaporating dish 1 gram of the ore, dried one hour at 100° to 105°C. and 5 cc. H_2O and mix thoroughly. Then add 90 cc. of the acid mixture and 10 cc. of concentrated sulfuric acid.

(b) Cover with watch glass and boil until the sulfuric acid fumes are given off copiously. Cool and dilute carefully to 150 cc. volume, washing cover glass and sides of the dish.

(c) Replace the cover glass and boil the solution carefully until the solution has a clear appearance.

(d) Filter the solution through an ashless filter into a 250 cc. flask and wash the residue with hot water until free from acid.

(e) Ignite the filter in a platinum crucible, cool in a desiccator and weigh.

(f) Moisten the residue in the crucible with two or three drops of water and 2 to 3 cc. of HF, and 3 drops of concentrated sulfuric acid. Evaporate slowly to dryness to avoid spattering, ignite, cool and weigh. The difference between the two weights obtained gives the silica content of the sample.

(g) If any appreciable residue remains in the crucible, it is brought into the solution by fusing it with a little potassium bisulfate and dissolving the resultant fusion in a very dilute sulfuric acid.

(h) This solution is then added to the original filtrate, the whole cooled to room temperature and made up to a volume of 250 cc. 25 cc. of this solution is then transferred with a pipette to a 100 cc. Nessler comparison tube and preserved for the determination of titanium.

2. Iron Oxide.

(a) The remainder of the solution is transferred to a 400 cc. beaker and evaporated to approximately 100 cc.

(b) 25 cc. of concentrated HCl are then added and the solution brought to boiling.

(c) The iron is reduced by adding drop by drop to the boiling hot solution, a concentrated solution of stannous chloride until the solution is colorless. The end point is sharp and not more than 2 drops should be added in excess.

(d) Cool the solution to room temperature and add, while stirring, 10 cc. of a saturated solution of mercuric chloride. Stir for about 30 seconds.

(e) The iron must be either titrated with bichromate solution, using potassium ferrocyanide as an external indicator, or with $KMnO_4$ solution according to the Reinhart Zimmerman method, which is as follows:

(f) Place 50 cc. of a preventative solution in a wide necked liter flask, containing 350 cc. of H_2O. Pour the reduced iron solution into this flask and, while whirling the flask, titrate with $KMnO_4$ solution to the appearance of a pink tinge. The end point is sharp, but lasts only for a minute.

The preventative solution contains:

160 grams of manganous sulfate
330 cc. 85 per cent phosphoric acid.
320 cc. sulphuric acid, Specific gravity 1.84.

3. Titanic Acid.

(a) To the 25 cc. solution in the Nessler Comparison tube add 50 cc. distilled water, then add 5 cc. of concentrated sulfuric acid and 5 cc. of 2 per cent H_2O_2 and make up to 100 cc.

(b) In another tube place 87 cc. of water, 5 cc. of concentrated sulfuric acid and 5 cc. of 2 per cent H_2O_2. Then from a burette add a standard titanic acid solution, mix and compare. Repeat until color matches. From the amount of the standard used the titanium content of the sample may be calculated, remembering that the sample taken for the titanium determination represents one tenth of the entire sample.

4. Loss on Ignition.

Place 1 gram of the ore dried at 100° to 105°C. in a weighed crucible and cover with a platinum lid. Heat slowly to a red heat for one hour at the hottest temperature obtainable on a blast lamp. Cool and weigh. The loss in weight represents combined water and organic mater.

5. Alumina.

The alumina is obtained by difference between the sum of the silica, titanium oxide, iron oxide and loss on ignition calculated in per cent and 100 per cent.

Ferguson Method of Analysis of Bauxite

The following method has been devised for the valuation of bauxite for alum manufacture, yielding alumina and iron available for such purposes. Owing to the differences which have resulted by deviating from this method, it is absolutely essential that each step be carefully followed unless it has been actually proved by experiments that the substituted modification yields the same results.

1. Preparation of the Sample.

The sample should be ground sufficiently fine to completely pass through a

100 mesh sieve and about 25 grams of the same are spread on a watch glass and dried at 212°F.

2. Digestion.

(a) Five grams of the dried sample are accurately weighed and transferred to a dry wide necked 200 cc. Jena glass Kjeldahl flask, having a capacity of 240 to 250 cc. when completely filled. Any particles of the sample adhering to the sides of the flask are washed down while adding 54 grams or 49 cc. of 20 per cent (235 g; or 127 cc. 96 per cent H_2SO_4 in 1 liter) sulfuric acid (equivalent to 75 per cent Al_2O_4). If a measured volume of acid is taken the volume should be carefully checked by weighing the amount delivered.

(b) As soon as the acid is added, the flask is connected with an upright reflux condenser of such a length that the vapor is completely condensed and of such diameter that the water can flow back freely. The flask is then heated over a wire gauze with a bunsen burner, burning so that the top of the flame just touches the wire gauze and protected from draughts by a burner guard. Under these conditions it takes about three minutes to bring the solution to boiling and the boiling is continued for exactly three hours.

(c) The solution is immediately filtered, carefully removing and washing all insoluble matter on to the filter and washing with hot water the solution running through the filter is no longer acid to litmus paper.

(d) The filtrate is made up to 1 liter and 100 cc. portions taken in No. 3 beaker for determination of alumina and ferric oxide and 200 cc. portions in a casserole for titration of iron.

3. Insoluble Residue.

(a) The filter paper containing the insoluble residue is ignited in a clean platinum dish or crucible over a bunsen burner, burning off all the paper and breaking up the residue, so as to get complete ignition.

(b) After cooling in a desiccator, the residue is carefully brushed onto the balance pan and weighed. This weight multiplied by 20 gives the percent of insoluble ignited residue.

4. Soluble Alumina.

(a) To the 100 cc. samples measured above, about 100 cc. of water, 10 cc. of HCl and a few drops of HNO_3 are added and the solution heated to boiling.

(b) Ammonium hydroxide is carefully added until the solution is just alkaline and after standing on the steam bath for 10 minutes, it is filtered through a 15 cm. paper, washed with hot water four times, allowing to drain well after each wash, and finally using the filter pump to suck the precipitate dry.

(c) Ignite in a platinum crucible at a low heat and when the paper is consumed, carefully grind down the lumps in the crucible with a smooth glass rod, blast for ten minutes, cool in desiccator and weigh.

(d) If the sample contains enough soluble iron to make the precipitate red, it should be ignited in a weighted platinum crucible, grinding and blasting as usual: when considerable iron is present, the precipitate sticks to the platinum after the blasting and cannot be brushed out. This weight multiplied by 200 gives the soluble alumina plus ferric oxide. Deducting the latter gives the soluble alumina.

Test of accuracy. The above method is intended to give an exact deter-

mination of alumina and ferric oxide and in order to test the ability of the analyst in the manipulation of the method under exacting conditions of apparatus and reagents, it is advisable to weigh out 20 grams of pure recrystallized potash alum, which has been finely ground and pressed between filter paper to remove occluded water. This is made up to one liter and 100 cc. portions taken in which the alumina is determined as described above. The weight of alum thus obtained should be 0.2154 gram of 10.77 per cent Al_2O_3.

The HNO_3 and boiling are intended to completely oxidize the iron.

SULFURIC ACID

(a) The percentage composition of sulfuric acid may be determined by hydrometer reading (Beaume scale for heavy liquids). Determinations made with temperature of acid at 60°F.

(b) From the Beaume the specific gravity or per cent of H_2SO_4 may be readily found in any of the reliable sulfuric tables.

SODA ASH

Sodium Carbonate.

(a) Dissolve 2 grams of the sample in 200 cc. of cold recently boiled distilled water.

(b) Titrate 50 cc. of this solution with N/2 H_2SO_4 using methyl orange as an indicator. The number of cc. of acid required, multiplied by 5.3 = per cent of Na_2CO_3.

LIME (FOR BOTH QUICK AND HYDRATED)

1A. Calcium oxide (CaO) Sugar Method.

(a) One-half gram of finely pulverized sample is dissolved in 100 cc. of a 10 per cent sugar solution and shaken for one hour on the shaking machine.

(b) The solution is filtered through a dry filter and 25 cc. of the solution titrated with N/10 H_2SO_4, using phenolphthalein as an indicator. The burette reading multiplied by 2.244 equals the per cent of water soluble calcium oxide.

1B. Calcium Oxide (CaO) Water Soluble Method.

(a) One-half gram of a finely pulverized sample is shaken with a little cold water in a 500 cc. graduated flask.

(b) The flask is filled to the mark with boiling distilled water. This is cooled and allowed to come to room temperature and again filled to the mark with recently boiled distilled water. This is then shaken for 30 minutes and allowed to stand for 24 hours.

(c) Then 100 cc. is titrated with N/10 H_2SO_4 using phenolphthalein as an indicator. The titration is then finished with methyl orange. Subtract the difference of the two titrations from the first or phenolphthalein titration and the result, multiplied by 2.805 equals the per cent of water soluble calcium oxide.

1C (Method adopted by Interdepartmental Committee United States Government.

(a) Weigh 1.4 grams of quicklime of 1.85 grams of hydrated lime which has

been carefully prepared and finely ground (passing a No. 100 sieve). Place in a 250 cc. beaker, add 200 cc. of hot water, cover, heat carefully and then boil for 3 minutes.

(b) Cool, wash down cover, add two drops of phenolphthalein and titrate with normal hydrochloric acid, adding the acid as rapidly as possible dropwise, stirring vigorously to avoid local excess of acid. When white spots appear, retard the rate of addition of acid somewhat, but continue until the pink color fades out throughout the solution for a second or two. Note the reading and ignore the return of color.

(c) Repeat the procedure of paragraph (a) above, using (instead of the beaker) a 0.5 liter graduated flask carrying a one hole stopper fitted with a short glass tube drawn out to a point. Cool, add dropwise 4.5 cc. less acid than before, stirring vigorously. Call the number of cc. used "A." Grind up any small lumps with a glass rod slightly flattened at one end, dilute to the mark with distilled water, stopper, mix thoroughly for 4 or 5 minutes and let settle for half an hour.

(d) Pipette a 200 cc. portion, add phenolphthalein and titrate slowly with a half-normal hydrochloric acid until colorless on standing one minute. Call this additional number of cc. "B." The per cent of available lime in quicklime or of available calcium hydroxide in hydrated lime is 2A + 2.5B.

2. Magnesia (MgO)

(a) The magnesia determination is made after removing silicon, alumina, iron oxide and lime.

(b) Ignite 1 gram, or if the magnesium content is high 0.5 gram, of the sample strongly in a platinum crucible for 15 minutes.

(c) When cool moisten the residue and dissolve it in It₀I hydrochloric acid, evaporate to dryness on the steam bath, take up in 5 cc. of hydrochloric acid, add 50 cc. of water and filter off the silica.

(d) To the filtrate add 5 cc. of hydrochloric acid, then make it slightly alkaline with ammonia, heat to boiling and filter off the oxides of iron and aluminum. Acidify the filtrate slightly, heat to boiling, add ammonium oxalate slowly to excess, then ammonia slowly.

(e) After the first precipitate has settled, filter and wash with an ammoniacal ammonium oxalate solution.

(f) Ignite the precipitate. When cool, moisten it, dissolve in hydrochloric acid and reprecipitate.

(g) Filter off the calcium oxalate, washing with ammoniacal ammonium oxalate solution.

(h) To the filtrate add an excess of microcosmic salt and more ammonia.

(i) After the precipitate has fully formed, preferably by standing over night, filter and wash with weak ammonia.

(j) Dissolve the precipitate in a slight excess of hydrochloric acid, add one or two drops of phosphate solution and reprecipitate by adding ammonia slowly while stirring.

(k) Filter, wash with weak ammonia and ignite to constant weight. Weight of magnesium pyrophosphate × 0.3621 × weight of magnesium oxide.

CHLORIDE OF LIME

Available Chlorine.

(a) Weigh 7.090 grams of the sample, previously well mixed; grind it with a little water in a porcelain mortar (the lip of which has been greased a little underneath) till a completely homogeneous thin paste has been obtained.

(b) Dilute with more water, wash the whole into a liter flask, fill up to the mark and take for each test 50 cc. = 0.3545 gram bleaching powder, having shaken up the flask immediately before.

(c) Run into the above, with continuous agitation, an alkaline N/10 arsenite solution, containing 4.95 g. As_2O_3 per liter till the expected point is not very far off. Then place a drop of the mixture onto a piece of filter paper, moistened with a starch solution containing potassium iodide. If there is very much chlorine left, a brown spot will be produced; if less chlorine, the spot will be blue. According to the depth of this color more or less arsenite solution is run in and the above test is repeated till the paper is colored hardly perceptibly, or not at all. Each cubic centimetre of the arsenite solution indicates 1 per cent available chlorine.

SULFATE OF IRON

1. Insoluble Matter.

(a) Treat 10 grams of the sample with 100 cc. of freshly boiled distilled water, cooled to 30°C. or less.

(b) When solution is complete, filter through a weighed Gooch crucible, wash, dry, cool and weigh. Report the weight of the residue, in percentage, as insoluble matter.

2. Iron as Ferrous Sulfate.

(a) Dissolve 1 gram of the sample and dilute to 200 cc. with freshly boiled distilled water cooled to 30°C. or less.

(b) Add 5 cc. of dilute sulfuric acid (1:3) to a 50 cc. portion of the solution and titrate with N/10 potassium premanganate. The percentage of ferrous sulfate ($FeSO_4 \cdot 7H_2O$) is equal to 11.12 times the number of cubic centimeters of potassium permanganate used.

3. Acidity.

(a) Shake 12.25 grams of the sample in 150 cc. bottle with 75 cc. of 95 per cent alcohol for ten minutes. Run a blank.

(b) Filter rapidly both sample and blank and wash rapidly with alcohol sufficient to make 100 cc. of filtrate.

(c) Titrate with N/10 sodium hydroxide in presence of phenolphthalein and subtract the result of titrating the blank from that of titrating the solution of the sample. The percentage of acidity expressed as sulfuric acid (H_2SO_4) is equal to 0.02 times the number of cubic centimeters of sodium hydroxide used.

OTHER STANDARD SPECIFICATIONS

For much of the less highly specialized material used in water works construction, operation and maintenance, widely recognized

specifications have been developed and more or less completely standardized, notably by the American Society for Testing Materials, the American Engineering Standards Committee and the Federal Specifications Board. These three organizations work in close coöperation; all seek to harmonize the interests of producer and consumer and to draft specifications which will result in a definite and uniform product of sufficiently high grade and which it is commercially feasible to produce.

The A. S. T. M., the oldest of these organizations, is a technical body composed of engineers, chemists, physicists and others concerned in the investigation, production, acceptance-testing and use of the materials of engineering. It initiates its own specifications. In addition to the properties of materials, it devotes especial attention to methods of inspection, analysis and testing.

The Federal Specifications Board is composed of representatives of the various purchasing agencies of the Federal Government, under the chairmanship of the Director of the Bureau of Standards. It is formulating uniform standard specifications to control purchases for all departments of the Federal Government, aiming to bring its specifications into line with the best commercial practice while maintaining, in essentials, the past high standard of Government specifications. While this is the youngest of these three organizations, the necessity of producing results for immediate use has led to the production of specifications for many materials not yet standardized by the A. S. T. M.

The American Engineering Standards Committee is composed of representatives of twenty-six national organizations in the engineering and allied fields, and of representatives of the Federal departments of Agriculture, Commerce, Interior, Labor, Navy and War, and of the Panama Canal. More than 200 national organizations, technical, industrial and governmental are participating in the work of its committee. The A. E. S. C. is a coördinating body. It neither proposes nor formulates specifications, but when the demand for a standard specification is demonstrated, it aims to secure the widest practicable participation in the formulation of the specification and in its subsequent adoption. The organization and methods of the A. E. S. C. qualify it to produce truly national standards. Specifications which have been approved under A. E. S. C. procedure are designated "American Standard" or "Tentative American Standard."

It is expected that, ultimately, A. E. S. C. "American Standard" or "Tentative American Standard" specifications will be available for substantially all widely used engineering materials and supplies for which national standardization is attempted. At present the A. S. T. M. list offers the greatest number of generally useful and widely recognized standard specifications.

A. S. T. M. standards and tentative standards are all copyrighted in the name of the Society. Permission to reprint any of these standards and tentative standards can be obtained only from the Executive Committee on application to the Secretary-Treasurer of the A. S. T. M., but it is usually sufficient to specify by serial designation and title as in the following example: Plates for standpipe shall fulfill the requirements for "Flange Steel" as given in the Standard Specifications for Boiler and Fire Box Steel for Locomotives, Serial designation A 30-24, of the American Society for Testing Materials. A. S. T. M. specifications generally provide for inspection of materials at the place of manufacture unless otherwise specified.

There follows a selection of current American Society for Testing Materials, American Engineering Standards Committee and Federal Specifications Board specifications of especial interest in the water works field. Since new specifications are being adopted and Tentative Specifications advanced to Standard, and since all specifications are subject to revision, current lists should be consulted and the latest editions of specifications used unless there are special reasons to the contrary. Each of these organizations will furnish, gratis, a current list of its specifications.

SPECIFICATIONS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS

Twenty-five cents per copy in lots of 1 to 50. Address American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa., giving both serial designation and title of the specifications, thus: "C 9-21 Standard Specification for Portland Cement." Figures following the dash indicate the year in which the specification was adopted or last revised; the letter T following the date indicates that the specification is tentative, thus: C 33-23 T is a tentative specification for concrete aggregates, last revised in 1923.

(A. S.) = "American Standard"; (T.A.S.) = "Tentative American Standard" of the A. E. S. C.

STEEL

Standard Specifications for:

A 9-24. Structural Steel for Buildings. Covers open hearth rivet and steel and both Bessemer and open hearth structural steel.

A 15-14. Billet-Steel Concrete Reinforcement Bars. Covers plain, deformed and cold-twisted billet-steel bars. Plain and deformed bars are of three grades, namely, structural-steel, intermediate and hard. Cold-twisted bars may be purchased on tests made either before or after twisting.

A 16-14. Rail-Steel Concrete Reinforcement Bars. Covers plain, deformed and hot-twisted rail-steel bars.[2]

A 27-24. Steel Castings. Covers Class A castings for which physical requirements are not, and Class B castings for which physical requirements are specified, the latter of three grades, hard, medium, and soft.

A 36-24. Recommended Practice for Heat Treatment of Carbon-Steel Castings.

A 30-24. Boiler and Firebox Steel for Locomotives. "Flange steel" of a 30-24 used for boiler shells (not fireboxes), riveted pipes, standpipes and important tanks.

A 31-24. Boiler Rivet Steel. For boiler, pipe, standpipe and tank rivets.

A 18-21. Carbon-Steel and Alloy-Steel Forgings. (T.A.S.) Covers 12 classes, including untreated and heat treated forgings, for structural purposes and for machinery parts.

A 53-24. Welded and Seamless Steel pipe. Covers "standard," "extra-strong" and "double extra strong" pipe intended for bending, flanging and other special purposes.[3]

STEEL AND WROUGHT IRON

Standard Specifications for:

A 83-24. Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes. Covers boiler tubes and flues, superheater tubes, safe ends and arch tubes.

A 56-24. Iron and Steel Chain. Covers five classes or qualities of chain, from ¼-inch to 2-inch bar.

Standard Methods of:

A 33-24. Chemical Analysis of Plain Carbon Steel.

WROUGHT IRON

Standard Specifications for:

A 72-24. Welded Wrought-Iron Pipe. Covers "standard," "extra-strong" and "soluble extra-strong" welded wrought-iron pipe, ⅛-inch to more than 12-inch diameter; includes pipe of "coiling or bending quality."

Standard Definitions of:

A 81-21. Terms Relating to Wrought-Iron Specifications.

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[2] For sizes, types, etc., see Simplified Practice Recommendations, following.

[3] Suitable for steam and other important lines in power plants and pumping stations with Van Stone joints and pipe bends, as well as for general use. While some makers advise that all of their pipe conforms to this specification, one of the largest makers advises that much of their pipe is mill-tested and sold under a less exacting specification, though at the same mill price. The Federal departments, on the other hand, buy welded steel pipe for all uses under a specification (Federal Specifications Board No. 162) even more exacting as to integrity of weld, and hydrostatic test of the larger sizes.

CAST IRON AND FINISHED CAST IRON CASTINGS

Standard Specifications for:

A 44-04. Cast-Iron Pipe and Special Castings. Listed for comparison with American Water Works Association Standard. Differs from A. W. W. A. specification chiefly in a few minor differences in dimensions, and in accepting a load on test bar for pipe 12 inches or less in diameter of 1900 pounds instead of 2000 pounds, and in requiring a deflection under 2000 pounds load of 0.32 inch instead of 0.30 inch in bars for pipe larger than 12 inches; also does not provide for alternative tensile test; the A. W. W. A. specification is recommended.

A 74-18. Cast-Iron Soil Pipe and Fittings.

A 47-24. Malleable Castings. Covers malleable castings for railroad, motor vehicle, agricultural implement and general machinery purposes, produced by either air-furnace, open-hearth, or electric-furnace process, and specifies same properties and tests for all.

A 48-18. Gray-Iron Castings. Covers "light," "medium" and "heavy" castings with different test requirements for each class.

A 88-24. High-Test Gray-Iron Castings. Includes semi-steel.

Standard Methods of:

A 64-16. Sampling and Chemical Analysis of Pig and Cast Iron.

METALLIC PROTECTIVE COATINGS FOR IRON AND STEEL

Standard Methods of:

A 90-24. Determining Weight of Coating on Zinc-Coated Articles. Describes one shop weighing test, three laboratory and three field tests, one of the laboratory methods being "Standard."

NON-FERROUS METALS

Standard and Tentative Standard Specifications for:

B 7-24 T. Manganese-Bronze Ingots for Sand Castings. (Tentative.)

B 54-24 T. Manganese-Bronze Sand Castings. (Tentative.) Covers castings made from ingots conforming to B -24 T; includes chemical analysis and physical properties. (See also Manganese Bronze under Discussion of Standard specifications, following.)

B 10-18. The Alloy: Copper, 88 per cent; Tin, 10 per cent; Zinc, 2 per cent. Covers the alloy commercialy known as government bronze, admiralty gunmetal, gun-metal or 88-10-2 mixture, when used in castings.

B 15-18. Brass Forging Rod. Covers rods of any specified cross-section capable of being readily forged hot and easily machined; chemical requirements but no tensile tests.

B 21-19. Naval Brass Rods for Structural Purposes. Covers rods of any uniform cross section, such as round, hexagonal, square, etc., requirements varying with diameter. Suitable for structural purposes as rods, bolts, etc., and is capable of being forged hot but is not free cutting.

B 30-22. Brass Ingot Metal, Graded and Ungraded, for Sand Castings. (T.A.S.) Covers "red" and "yellow" brass ingot, made wholly or partly from scrap; seven grades, also ungraded.

B 31-21. Bronze Bearing Metal in Ingot Form. Covers 6 grades of copper-tin-lead alloys, made wholly or partly from scrap material.

B 23-18 T. White Metal Bearing Alloys (Tentative). Covers 12 grades of "babbitt metal."

B 32-21. Solder Metal. (T.A.S.) Covers two classes and a total of 11 grades of lead-tin alloys used for "soft solder."

B 42-24. Copper Pipe, Standard Sizes. Covers seamless copper tubes and pipe suitable for use in plumbing, boiler feed lines, etc.; bending temper to be specified if required.

B 43-24. Brass Pipe, Standard Sizes. Covers seamless brass pipe suitable for use in plumbing, boiler feed lines, etc.; bending stock to be specified if required.

B 44-24. Seamless Admiralty Condenser Tubes and Ferrule Stock. Covers seamless tubes and ferrule stock made from admiralty alloy, 70 per cent copper, 1 per cent tin, and 29 per cent zinc.

B 55-24 T. Seamless 70-30 Brass Condenser Tubes and Ferrule Stock. (Tentative.)

B 56-24 T. Seamless Muntz Metal Condenser Tubes and Ferrule Stock. (Tentative.)

Standard Methods of Chemical Analysis of:

B 18-21. Alloys of Lead, Tin, Antimony and Copper. (T.A.S.)
B 27-19. Manganese. Bronze. (T.A.S.)
B 28-19. Gun Metal. (T.A.S.)
B 45-23. Brass Ingots and Sand Castings.
B 46-23. Bronze Bearing Metal.

CEMENT, LIME AND CLAY PRODUCTS

Standard and Tentative Specifications for:

C 9-21. Portland Cement. (A.S.) (See also Portland Cement under Discussion of Standard Specifications, following.)

C 9-16 T. Compressive Strength of Portland Cement Mortars. (Tentative. To be added when approved, to C 9-21.)

C 10-09. Natural Cement.

C 33-23 T. Concrete Aggregates. (Tentative.) Covers fine and coarse aggregates including sand, stone screenings, crushed stone, gravel and slag: Acceptance based on description and sieve tests plus concrete strength tests. or alternatively for sand, on mortar strength tests.

Standard and Tentative Methods of:

C 29-21. Test for Unit Weight of Aggregate for Concrete. (T.A.S.) To determine weight of a given volume of dry aggregate, fine, coarse or mixed, with air-filled voids, relative to the same volume of water.

C 30-22. Test for Voids in Fine Aggregate for Concrete. (T.A.S.) Requires determination of "apparent specific gravity" by methods of D 55.

C 31-21. Making and Storing Specimens of Concrete in the Field. Covers moulding and storing of test specimens sampled from concrete being used in construction.

C 39-21 T. Making Compression Tests of Concrete. (Tentative.)

C 40-22. Test for Organic Impurities in Sands for Concrete. (T.A.S.) Covers the sodium hydroxide test, which test is intended as an indication whether the presence of organic compounds requires further tests of the sand before its use in concrete.

C 41-24. Test for Sieve-Analysis of Aggregates for Concrete.

C 42-21 T. Securing Specimens of Hardened Concrete from the Structure. (Tentative.)

C 44-22 T. Tentative Rules for Inspection of Concrete and Reinforced Concrete Work. Covers qualifications of the inspector, and his duties in detail.

C 7-15. Paving Brick. Covers rattler test and visual inspection only.[4]

C 21-20. Building Brick. Covers absorption, compression and transverse tests.[4]

C 32-24. Clay Sewer Brick. Covers four classes according to resistance to abrasion required; provides for optional chemical tests and requirements; specific size, visual inspection, absorption, compression and transverse tests.

C 4-24. Drain Tile. Covers three classes, Farm Drain Tile, Standard Drain Tile and Extra-Quality Drain Tile. Sizes 4 to 42 inches.

C 13-24. Clay Sewer Pipe. Covers clay products intended to be used for the conveyance of sewage, industrial wastes, and storm water. Sizes 4 to 42 inches.

C 14-24. Cement-Concrete Sewer Pipe. Covers cement-concrete products intended for the conveyance of sewage, industrial wastes and storm water. Sizes 4 to 42 inches.

C 15-17 T. Required Safe Crushing Strengths of Sewer Pipe to Carry Loads from Ditch Filling (Tentative). Gives required safe crushing strengths per linear foot of pipe, for different kinds of depths of ditch filling material over pipe, and different widths of ditch, when pipe is laid in accordance with C 12-19.

Standard Definitions of:

C 8-24. Terms Relating to Sewer Pipe.

Recommmended Practice for:

C 12-19. Laying Sewer Pipe.

COAL COKE AND LUBRICANTS

Standard and Tentative Methods of:

D 21-16. Sampling Coal. (T.A.S.)

D 22-24. Laboratory Sampling and Analysis of Coal.

D 197-24 T. Test of Fineness of Powdered Coal. (Tentative.)

D 37-24. Laboratory Sampling and Analysis of Coke.

D 47-24. Test for Specific Gravity of Lubricants.

Definitions of:

D 121-24 T. Terms Relating to Coke. (Tentative.)

D 142-24 T. Terms Relating to Coal. (Tentative.)

For Fuel Oil and Lubricants, see Specification 2c of the Federal Specifications Board.

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[4] For sizes, types, etc. see Simplified Practice Recommendations, following.

TIMBER

Standard and Tentative Specifications for:

D 10-15. Yellow-Pine Bridge and Trestle Timbers.

D 23-20 T. Structural Douglar Fir. (Tentative.) Covers "dense Douglas fir" and two structural grades.

Standard Definitions of:

D 9-15. Terms Relating to Structural Timber.

RUBBER PRODUCTS

Standard and Tentative Specifications for:

D 14-23. Cotton Rubber-Lined Fire Hose for Private Fire Department use. Covers hose from 1½-inch single and double jacket to 3½-inch double and triple jacket.

D 26-23. Cotton Rubber-Lined Fire Hose for Public Fire Department Use. Covers 2½, 3 and 3½ inches double-jacketted hose.

D 53-24. Rubber Belting for Power Transmission. Covers friction-covered and rubber-covered belting.

D 54-24 T. Steam Hose. (Tentative.) Covers wrapped fabric hose suitable for steam at pressures not exceeding 125 pounds per square inch, wire armored when so specified. Sizes ⅜-inch to 2-inch.

D 151-23. Rubber Pump Valves. Covers valves for pumps equipped with grid-type seats and which are used for pumping fluids having very slight, if any, effect on rubber; five grades for various temperatures and pressures.

D 177-24. Wrapped Cold Water Hose. Covers cold water hose for other public fire department use; sizes, ½-inch to 4-inch.

Standard Methods of:

D 15-24. Testing Rubber Products. Includes tests of belting, fire and other hose.

Packing. For rubber and many other packings see Specifications 93 to 113, inclusive, of the Federal Specifications Board.

ROAD MATERIALS—AGGREGATES

Standard and Tentative Methods of Test for:

D 30-18. Apparent Specific Gravity of Coarse Aggregates. (T.A.S.) For concrete aggregates as well as road metal.

D 55-24. Apparent Specific Gravity of Sand, Stone, and Slag Screenings and other Fine Non-Bituminous Highway Materials. Primarily for highway materials but used in determining voids in fine aggregates for concrete, C 30-22.

D 136-22 T. Decantation Test for Sand and Other Fine Aggregates, (Tentative.) Covers the determination of the total quantity of silt, loam, clay, etc., in sand and other fine aggregates.

MISCELLANEOUS SUBJECTS

Standard and Tentative Methods of:

E 4-24. Verification of Testing Machines.

E 4-24 T. Verification of Testing Machines by Means of an Elastic Calibration Bar. (Tentative. To be added, when adopted, to E 4-24).

E 8-24 T. Tension Testing of Metallic Materials. (Tentative.)

E 9-24 T. Compresssion Testing of Metallic Materials. (Tentative.)

E 10-24 T. Brinell Hardness Testing of Metallic Materials. (Tentative.)

Tentative Definitions of:

E 6-24 T. Terms Relating to Methods of Testing.

OTHER A. S. T. M. SPECIFICATIONS

In addition to the specifications listed above, the A. S. T. M. Standards and Tentative Standards include many specifications for materials and methods which may be required in water works practice, includiug metals and alloys for special purposes; building materials, such as quicklime and hydrated lime, galvanized sheets, concrete building brick, hollow burned-clay tile, gypsum and gypsum products, and refractories; and paint oils, turpentine oleo-resinous varnishes and pigments, but not ready mixed paints for which see footnote to specifications of the Federal Specifications Board. The A. S. T. M. list also includes methods for testing lubricants and other petroleum products including kerosene and gasoline, but not specifications for the properties of these materials, for which see F. S. B. Specification 2c; and it includes many specifications for road materials and waterproofing materials.

SPECIFICATIONS OF THE AMERICAN ENGINEERING STANDARDS COMMITTEE

Price as indicated. Address American Engineering Standards Committee. 29 West 39th Street, New York, N. Y.

(A.S.) = American Standard; (T.A.S.) = Tentative American Standard.

In addition to the A. S. T. M. Standards which have been adopted by the American Engineering Standards Committee as American Standards or Tentative American Standards, the following additional A. E. S. C. specifications are pertinent (A. E. S. C. designation):

B 1a-1924. Screw Threads. (A.S.) Sponsored by American Society of Mechanical Engineers and Society of Automotive Engineers (50 cents).

B 2-1919. Pipe Thread. (A.S.) Sponsored by American Gas Association and American Society of Mechanical Engineers (40 cents).

B 26-1924. Screw Threads for Fire Hose Couplings. (A.S.) Submitted by American Society of Mechanical Engineers, National Board of Fire Underwriters, National Fire Protection Association.[5]

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[5] In press.

In addition to specifications for materials the A. E. S. C. list includes a variety of mechanical safety codes for the protection of industrial workers, a Code of Lighting for Factories, Mills and other Work Places (A.S.), the National Electrical Code (A.S.) for wiring, etc. in relation to fire hazard, and the National Electrical Safety Code (A.S.), many of which are applicable to water works shops, pumping stations and filter plants. The following are some of the item for which A. E. S. C. specifications are in preparation: B 16, Pipe Flanges and Fittings; B 18, Bolt, Nut and Rivet Proportions; G 8, Zinc Coating of Iron and Steel.

UNITED STATES GOVERNMENT MASTER SPECIFICATIONS

FEDERAL SPECIFICATIONS BOARD STANDARDS

For specifications that have a Bureau of Standards number or other Bureau number in addition to the F. S. B. number, address Superintendent of Documents, Government Printing Office, Washington, D. C. giving Bureau number and title. For current lists of specifications (grattis) and for specifications bearing F. S. B. number only, address Federal Specifications Board, Bureau of Standards, Washington, D. C.

U. S. Government Specifications for

F. S. B. Number

2c Lubricants and Liquid Fuels and Methods for Testing. Covers fuel oil, motor gasoline, and many lubricants including crank-pin and cup greases, and oils for machinery, steam turbines, electrical machinery, Diesel engines, other internal combustion engines, steam cylinders, gears, and automobile transmissions, etc. (15 cents, Superintendent of Documents; order Bureau of Mines Technical Paper No. 323 A.)

93 Asbestos-Copper Gaskets, Corrugated. Covers corrugated copper gaskets lined with asbestos.

94 Asbestos Metallic Cloth Sheet Packing and Gaskets for High Pressure Steam. Covers high pressure steam packing and gaskets for boiler manholes, handholes and flange joints.

95 Asbestos Valve Stem Packing. Covers both braided and twisted asbestos packings for steam pressures up to 300 pounds per square inch and a maximum temperature of 700°F.

96 Compressed Asbestos Sheet Packing, Grade I. Covers packing for steam joints under pressures up to 350 pounds per square inch and a maximum temperature of 700°F., and for joints of internal combustion engines.

97 Compressed Asbestos Sheet Packing Grade II. Covers packing for steam joints under pressures up to 300 pounds per square inch and a maximum temperature of 600°F. and for internal combustion engines.

98 Diaphragm Packing. Covers packing for making diaphragms for pumps.

99 Fabric Condenser Tube Packing. Covers the packing commercially known as cotton corset lacing.

100 Fiber Packing for Lubricating and Fuel Oils. Covers impregnated paper sheet packing for joints of oil, grease and gasoline lines.

101 Flax Packing.

102 Flexible Metallic Packing. Covers packing for steam pressures up to 300 pounds per square inch on rods having reciprocating, oscillating rotary, or helical motion; suitable also for gas and liquid pressures.

103 High Pressure Spiral Gland Packing. Covers woven asbestos cloth and rubber packing for piston rods, valve stems and slip joints at steam pressures up to 300 pounds per square inch with a maximum temperature of 700°F.

104 Low Pressure Spiral Gland Packing. Covers oil-impregnated, graphited, square or rectangular low pressure packing.

105 Metallic Packing—Fixed Ring Type. Covers packing for steam pressures up to 300 pounds per square inch on rods having reciprocating, oscillating or rotary motion; suitable also for gas pressures.

106 Plastic Metallic Packing. Covers packing for steam pressures up to 300 pounds per square inch on rods having reciprocating, oscillating, rotary or helical motion; suitable also for gas and liquid pressures.

107 Semi-Metallic Packing. Covers packing to be used for superheated steam and high-pressure steam.

108 Solid Metallic Packing—Floating Ring Type. For steam pressures up to 300 pounds per square inch on rods having reciprocating motion.

109 Packing Rings for Boiler Blow-Off Valves.

110 Cloth-Insertion Rubber Packing. Covers two grades of sheet packing for cold water gaskets, Grade I for flanges to be separated along intervals, Grade II for flanges to be separated frequently.

111 Rubber Packings and Gaskets (Moulded, Sheet and Strip). Covers three grades, Grade III being for use with cold water, hot water, or temporarily for steam up to 150 pounds per square inch.

112 Wire Insertion Rubber Packing. Covers sheet packing for hot or cold water flange joints and for steam up to 150 pounds per square inch.

113 Tucks Packing. Covers square and round packing for stuffing-boxes and pistons in pumps and engines.

In addition to the specifications listed above, the F. S. B. list contains specifications for several semi-paste and ready-mixed paints, for varnishes, and for many paint materials, including, in each case, methods of analysis and test, and for many other materials and supplies used by the several departments of the Federal Government.

DISCUSSION OF THE PRECEDING STANDARD AND TENTATIVE STANDARD SPECIFICATIONS

Comment on two of the preceding specifications follows.

Portland Cement.

The A. S. T. M. Standard specification for portland cement, C9-21, which is also the American Standard of the A. E. S. C., is presented with full realization that our knowledge of portland cement is imperfect and that a cement meeting the requirements of this specification may not produce sound concrete and durable structures, under certain occasional conditions, particularly with weather exposure. Pending a more comprehensive study than has yet been made, C 9-21 is the only generally recognized specification available. The Board of Water Supply of the City of New York uses C 9-21 except for the following requirements:

(a) Sulphuric anhydride (SO_3) and magnesium oxide (MgO) shall not exceed 1.75 and 4.00 per cent respectively, these being the values in force before specification C 9 was relaxed in 1917; and

(b) *In recent specifications only,* the molecular ratio of the calcium oxide divided by the sum of the molecular ratios of the silica, alumina and ferric oxide shall, in general, be greater than 2.40.

The sulphuric anhydride and magnesium oxide are held down mainly because there appears to be no sufficient reason for relaxing these requirements. The molecular ratio requirement is designed to insure sufficient lime to produce the several cementing ingredients in what seem to be desirable proportions;[6] and while this requirement has not been in force long enough conclusively to prove its worth, the indications are that it is a useful provision, at least with current American portland cements. No case of disintegration of *underground* concrete placed either before or since the adoption of this requirement is known, except where exposed to "alkali" or sulphate ground waters.

THE MEANING AND USE OF STANDARD SPECIFICATIONS

The preceding standard and tentative standard specifications are not offered as theoretically ideal, nor even as necessarily representing in all cases the best commercially obtainable product. Rather they probably represent, in general, about the best commercial grades

[6] "Judging the Quality of Portland Cement," by R. J. Colony, Trans. Am. Inst. Mining Eng., 1921.

which the majority of manufacturers are prepared to furnish and which buyers who provide systematic inspection can obtain. In certain cases, manufacturers who specialize on quality produce materials of higher grade, and certain large buyers demand and get them. Nevertheless, in the interest of simplicity, economy, more prompt delivery, and the avoidance of misunderstanding, resulting from ordering materials conforming to widely recognized specifications in the preparation of which producers as well as consumers have participated, the general use of these standard and tentative standard specifications is recommended. This does not mean that other specifications should not be used where the buyer already has a specification which he is convinced actually gets him a product better adapted to his needs, or where exceptional conditions demand an exceptional product and warrant the trouble and cost of getting it. Even in such cases it will frequently be convenient and useful to all concerned to refer to the standard specification as a base and write in full only the exceptions or additional requirements.

GETTING SPECIFICATION MATERIAL

The problem of getting materials that actually conform to standard specifications presents no particular difficulty to the large buyer who maintains his own efficient inspection organization, or even to the buyer direct from the mill whose orders are large enough to warrant employment of a reliable commercial inspection organization to make mill inspections and acceptance tests. For the smaller buyer, particularly when buying from dealers stock, the problem is difficult, since standard specification grades are not yet generally recognized by dealers. Certain makers will furnish on mill orders, if demanded, the heat numbers and certified copies of analyses and tests. Certain recent specifications provide that ingots of alloys shall be stamped with the A. S. T. M. specification number, and the grade. A committee of the A. S. T. M. is studying methods of identifying materials to the end that standard specification materials shall be made available with certainty to small buyers. An insistent demand on the part of buyers for evidence that the material offered them conforms to a standard specification should advance this most important end.

SIMPLIFIED PRACTICE RECOMMENDATIONS

The Division of Simplified Practice of the Department of Commerce was organized in 1921 to reduce industrial waste by the elimi-

nation of unnecessary sizes, grades, etc., of manufactured products. While not specifications in the sense of prescribing properties and acceptance tests, the Simplified Practice Recommendations of the Division indicate the sizes, and in certain cases the grades, finishes and packages, in which it is expected that the materials covered by these recommendations will, hereafter, be generally available. The simplification of sizes, grades, etc. of any product has generally been merely an elimination of those kinds least in demand; it is initiated by trade associations of the producers concerned; the project is reviewed by a general conference representing producers, distributors, and, so far as may be, consumers; the resulting recommendation is submitted for acceptance to interested organizations including trade and technical associations and government departments; and before approval and publication by the Department of Commerce, the recommendation must have been adopted by at least 80 per cent of the manufacturers concerned, "and by a sufficient number of the distributing and consuming interests to demonstrate their belief that the eliminations recommended are in the public interest." Periodic revisions are provided for.

To the extent that producers and distributors adhere to the Simplified Practice Recommendations, the effect should be to expedite deliveries and reduce the cost of recognized sizes, grades, etc., and at the same time to retard deliveries and increase the cost of unrecognized sizes, grades, etc. These Recommendations tend to eliminate from dealers' stocks all unrecognized varieties and to eliminate from the producers' plants any specialized equipment necessary for making them; they tend, therefore, to drive unrecognized varieties from the market.

Simplified Practice Recommendations are being issued or revised at short intervals. Current lists can be had gratis from the Division of Simplified Practice, Department of Commerce, Washington, D. C. Current recommendations applicable to the water works field are as follows:

SIMPLIFIED PRACTICE RECOMMENDATIONS

Generally, five cents per copy except as noted. Address Superintendent of Documents, Government Printing Office, Washington, D. C. giving Simplified Practice Recommendation Number and title.

No.	*Title*
1	Paving Bricks. Covers sizes, varieties and tolerances.
3	Metal Lath. Covers types and weights.
4	Asphalt. Covers penetration limits for asphalt for sheet asphalt, asphaltic concrete, asphalt macadam, asphalt for surface treatment of pavements, and joint fillers.
7	Face Brick and Common Brick. Recommends that recognized approximate dimensions in inches, conform to the following: Common brick and rough face brick: 8 x $2\frac{1}{4}$ x $3\frac{3}{4}$ inches. Smooth face brick: 8 x $2\frac{1}{4}$ x $3\frac{7}{8}$ inches.
8	Range Boilers and Expansion Tanks. Covers dimensions, capacities and tapping.
9	Woven-Wire Fencing. Covers styles, wire gages, spacing of stays, and packages; covers field fence up to 55 inches high, close field fence up to 46 inches, wolf-proof fence up to 48 inches and poultry fence.
12	Hollow Building Tile. Covers dimensions, weights and tolerances.
14	Roofing Slate. Covers dimensions and definitions of terms.
16	Lumber. Covers grades and dimensions of "yard lumber," i.e., lumber less than 6 inches thick intended for general building purposes. (15 cents.)
17	Forged Tools. Covers sizes, types and weights of picks, mattocks, bars, wedges, blacksmith tools, sledges and heavy hammers.
21	Brass Lavatory and Sink Traps. Covers types and sizes.
25	Hot Water Storage Tanks. Covers dimensions, capacity, working pressures, classification and marking, factors of safety, tappings, manholes and heating coils.
26	Steel Reinforcing Bars. Recommends that reinforcing bars be limited to seven sizes of round bars, namely $\frac{1}{4}$-inch, $\frac{3}{8}$-inch, $\frac{1}{2}$ -inch, $\frac{5}{8}$-inch, $\frac{3}{4}$-inch, $\frac{7}{8}$-inch and 1-inch, and four sizes of square bars, namely $\frac{1}{2}$-inch, 1-inch, $1\frac{1}{8}$-inch and $1\frac{1}{4}$-inch, these 11 sizes together affording a graduated series of areas. Applies to bars having rolled deformations and is intended to eliminate square twisted bars.

TYPHOID FEVER IN THE LARGE CITIES OF THE UNITED STATES IN 1924[1]

The Journal of the American Medical Association presents its thirteenth annual survey[2] of typhoid fever mortality in the sixty-nine cities of the United States that had more than 100,000 population in 1920.[3] In the preceding reports the cities have been grouped according to population, but this year a departure has been made and the recognized geographic divisions of the United States Census Bureau have been used instead. The typhoid mortality rates in previous years have been shown to bear no demonstrable relation to the size of the city population, and on the other hand there has been shown a significant connection between geographic location and typhoid mortality. It is thought that this may be brought out more clearly by a definite geographic arrangement.

The cities of the New England group (table 1) have for the most part exceedingly low typhoid rates. Two cities in this group, Fall River and Hartford, report no typhoid deaths for 1924, and are the only cities in the United States with a population over 100,000 to show a perfectly clean typhoid slate. It seems hardly worth while to institute comparisons within this group for the calendar year 1924, since the actual number of deaths is so small that chance fluctuations in the number of imported cases might well account for the slight differences that are observed. It is hoped that in

[1] Reprinted by permission, from the Journal of the American Medical Association, **84**: 11, March 14, 1925, page 813.

[2] The preceding articles were published, Jour. Amer. Med. Assoc. May 31, 1913, p. 1702; May 9, 1914, p. 1473; April 15, 1915, p. 1322; April 22, 1916, p. 1305; March 17, 1917, p. 845; March 16, 1918, p. 777; April 5, 1919, p. 997; March 6, 1920, p. 672; March 26, 1921, p. 860; March 25, 1922, p. 890; March 10, 1923, p. 691, and February 2, 1924, p. 389.

[3] The deaths from typhoid in each city are those reported to us by the respective health departments. The rates have been calculated on the basis of midyear 1924 population, estimated by the method of the United States Census Bureau, save that in five instances, Hartford, Bridgeport, Washington, Akron and Youngstown, the 1920 census enumeration has been used.

the near future it may be possible to distinguish more definitely than heretofore between the out-of-town cases brought to city hospitals and those occurring among city residents, thereby giving

TABLE 1

Death rates of cities in New England States from typhoid per hundred thousand population

	1924	1923	1922	1921	1916–1920	1911–1915	1906–1910
Fall River	0.0	4.1	3.3	2.4	8.5	13.4	13.5
Hartford	0.0	0.7	2.8	7.2	6.0	15.0	19.0
Worcester	0.5	2.6	3.1	3.2	3.5	5.0	11.8
Springfield	1.3	1.4	1.4	4.4	4.4	17.6	
Lowell	1.7	2.6	2.6	5.2	5.2	10.2	13.9
Boston	2.1	1.0	1.4	3.1	2.5	9.0	16.0
Providence	2.5	0.8	0.0	2.5	3.8	8.7	21.5
Bridgeport	3.5	1.4	0.6	2.7	4.8	5.0	10.3
Cambridge	4.5	3.6	0.9	10.8	2.5	4.0	9.8
New Bedford	4.5	0.8	0.0	2.3	6.0	15.0	16.1
New Haven	5.1	4.6	5.8	4.7	6.8	8.2	30.8

TABLE 2

Death rates of cities in Middle Atlantic States from typhoid per hundred thousand population

	1924	1923	1922	1921	1916–1920	1911–1915	1906–1910
Trenton	0.8	11.8	15.9	8.9	8.6	22.3	
Rochester	1.2	1.9	2.5	3.2	2.9	9.6	12.8
Syracuse	1.6	2.2	1.6	3.9	7.7	12.3	15.6
Philadelphia	2.2	1.7	2.7	2.3	4.9	11.2	41.7
Jersey City	2.6	1.6	1.6	3.5	4.5	7.2	12.6
Newark	2.7	2.3	2.7	2.8	3.3	6.8	14.6
Yonkers	2.7	0.9	0.0	2.9	4.8	5.0	10.3
Buffalo	2.8	4.3	3.5	4.2	8.1	15.4	22.8
Scranton	2.8	1.4	1.4	6.5	3.8	9.3	31.5
New York	3.1	2.4	2.2	2.1	3.2	8.0	13.5
Paterson	3.6	2.9	2.1	5.8	4.1	9.1	19.3
Pittsburgh	3.9	3.7	4.6	4.1	7.7	15.9	65.0
Reading	5.4	2.7	9.2	11.7	10.0	31.9	42.0
Camden	6.3	4.0	5.7	6.6	4.9	4.5	
Albany	12.6	3.4	1.7	4.3	8.0	18.6	17.4

a truer picture of the indigenous typhoid. Even if it is possible to do this, however, there still remains the problem of separating the

infections contracted within the city limits from those contracted elsewhere. Conditions over which the municipality itself has no control in the suburbs and in the hinterland may well be responsible for a large share of the typhoid in cities in certain sections of the country.

So far as the New England cities are concerned, the main features that call for remark are the fine record made by Providence for the last four years, the increase in the Boston rate in 1924 as compared with 1922 and 1923, and the fact that for three years in succession the city of New Haven has had the highest rate of any city in the New England group.

In the Middle Atlantic states (table 2) there are more cities with more than 100,000 population than in any other geographic division. It is encouraging, therefore, to find that more than half the cities in this group report 1924 typhoid rates of less than 3. The low rate in the city of Trenton deserves especial mention, since for a number of years this city has suffered from a higher average typhoid rate than most of its neighbors.

New York had a higher typhoid mortality in 1924 than for several years. According to a preliminary report of the United States Public Health Service, the somewhat excessive 1924 rate was due to contaminated oysters. An unusual prevalence of oyster-borne infections seems, indeed, to be the outstanding feature in urban typhoid epidemiology in this country in 1924. As many as 650 excess cases of typhoid in New York have been attributed to this source. In addition, Chicago is thought to have had about 100 and Washington about fifty cases of oyster-borne infection. The full government report, setting forth the detailed evidence for this opinion, has not yet been published;[4] but, as stated previously in the Journal of the American Medical Association,[5] the evidence collected by the individual health departments, as well as by the Public Health Service, is quite convincing. If present indications are confirmed by further information, this is one of the largest

[4] Since the preparation of the A. M. A. report, the U. S. Public Health Service report on the oyster-borne epidemics has been published. Cf. "A Typhoid Fever Epidemic Caused by Oyster-Borne Infection (1924–25)," by Lumsden, Hasseltine, Leake and Veldee. Supplement No. 50, Public Health Reports.—*Editor.*

[5] Oysters and Typhoid, editorial, Jour. Amer. Med. Assoc., **84:** 286 (January 24). 1925.

groups of cases—if not the largest—ever traced to contaminated shellfish. This occurrence raises the suspicion that this mode of infection may have played a larger part in typhoid causation in earlier years, but was so completely submerged by the great mass

TABLE 3

Death rates of cities in South Atlantic States from typhoid per hundred thousand population

	1924	1923	1922	1921	1916–1920	1911–1915	1906–1910
Richmond	1.1	5.5	4.4	5.6	9.7	15.7	34.0
Baltimore	2.8	4.3	4.0	5.4	11.8	23.7	35.1
Norfolk, Va.	2.9	0.0	6.4	4.1			
Washington	4.3	6.0	5.2	6.6	9.5	17.2	36.7
Wilmington	8.3	2.6	5.1	4.4			
Atlanta	15.0	17.1	10.9	11.0	14.2	31.4	58.4

TABLE 4

Death rates of cities in East North Central States from typhoid per hundred thousand population

	1924	1923	1922	1921	1916–1920	1911–1915	1906–1910
Akron	1.0	1.4	1.9	5.7			
Milwaukee	1.0	1.0	2.5	1.9	6.5	13.6	27.0
Cleveland	1.2	1.7	2.2	3.4	4.0	10.0	15.7
Chicago	1.6	1.9	1.0	1.1	2.4	8.2	15.8
Dayton	2.4	3.6	3.7	5.2	9.3	14.8	22.5
Cincinnati	2.5	3.2	2.9	3.4	3.4	7.8	30.1
Detroit	3.0	4.0	5.0	5.8	8.1	15.4	22.8
Grand Rapids	3.4	1.4	0.6	2.8	9.1	25.5	29.7
Columbus	3.7	4.6	1.1	4.0	7.1	15.8	40.0
Indianapolis	3.9	2.6	5.4	7.3	10.3	20.5	30.4
Toledo	4.4	6.0	3.8	8.6	10.6	31.4	37.5
Youngstown	4.5	7.6	6.2	15.0			

of water-borne and milk-borne cases that it could not be readily detected. In view of the publicity given to the 1924 typhoid outbreak, it is safe to say that oyster-borne infection will be even more carefully guarded against in the future than it has been in the past.

Among the other cities in the Middle Atlantic states, Rochester and Syracuse seem to be maintaining consistently excellent records. Camden, on the other hand, has had a higher typhoid average for the four years 1921 to 1924 than for the ten years preceding, a

circumstance that would seem to call for inquiry. Albany appears to have had what might be termed an epidemic, the number of typhoid deaths in 1924 being considerably in excess of the total for the three preceding years.

TABLE 5

Death rates of cities in East South Central States from typhoid per hundred thousand population

	1924	1923	1922	1921	1916–1920	1911–1915	1906–1910
Louisville	1.9	3.5	8.0	5.5	9.7	19.7	52.7
Birmingham	7.5	7.7	12.5	17.0	31.5		
Nashville	20.4	12.3	16.2	20.4	20.7	40.2	61.2
Memphis	41.2	13.6	8.9	9.0	27.7	42.5	35.3

TABLE 6

Death rates of cities in West North Central States from typhoid per hundred thousand population

	1924	1923	1922	1921	1916–1920	1911–1915	1906–1910
Omaha	1.0	5.4	4.4	4.0	5.7	14.9	40.7
St. Paul	2.0	3.3	2.0	7.1	3.1	9.2	12.8
Minneapolis	2.1	1.0	1.9	1.2	5.0	10.6	32.1
Des Moines	2.8	0.7	1.5	1.4			
Kansas City, Mo	3.6	7.1	4.9	11.0	10.6	16.2	35.6
St. Louis	3.7	4.0	4.2	3.8	6.5	12.1	14.7
Kansas City, Kan	4.6	0.9	7.0	4.8	9.4		

TABLE 7

Death rates of cities in West South Central States from typhoid per hundred thousand population

	1924	1923	1922	1921	1916–1920	1911–1915	1906–1910
Fort Worth	1.7	4.9	7.8	10.7			
Houston, Texas	5.6	7.8	7.3	11.7			
San Antonio	5.8	9.8	5.6	16.6	23.3	29.5	
Dallas	8.2	11.6	5.8	12.7	17.2		
New Orleans	10.0	8.7	10.2	9.3	17.5	20.9	35.6

The cities in the South Atlantic states (table 2) have had a year of excellent record, Richmond, Baltimore and Washington reporting the lowest typhoid rates in their history. Baltimore, among the twelve largest cities in the country, makes a surprisingly low

record. It could hardly have been anticipated ten years ago that Baltimore would in a short time be able to record a lower typhoid rate than New York. If the typhoid improvement in this group as a whole is maintained, the Northern cities will have to look out for their laurels.

The cities in the East North Central states (table 4) have maintained, on the whole, excellent records. Only one city in this group has reported a rate of more than 10 in the last four years. Indianapolis and Toledo have not yet got into the race for the leadership, but are showing signs of a typhoid stabilization which looks promising for the future. Chicago, which suffered slightly in 1923 from water-borne typhoid, has this year experienced some oyster-borne

TABLE 8

Death rates of cities in Mountain and Pacific States from typhoid per hundred thousand population

	1924	1923	1922	1921	1916–1920	1911–1915	1906–1910
Oakland	1.3	3.3	3.0	1.3	3.8	8.7	21.5
Spokane	1.9	7.7	5.7	4.7	4.9	17.1	50.3
San Francisco	2.6	3.0	2.2	4.2	4.6	13.6	27.3
Seattle	3.2	2.5	2.8	2.2	2.9	5.7	25.2
Tacoma	3.9	5.9	4.0	3.0	2.9	10.4	19.0
Los Angeles	4.4	3.1	3.7	2.6	3.6	10.7	19.0
Denver	5.1	5.2	5.9	4.5	5.8	12.0	37.5
Portland, Ore	6.1	2.9	3.3	3.0	4.5	10.8	23.2
Salt Lake City	10.1	4.0	3.2	5.7	9.3	13.2	

infection, but the excess cases, while raising the 1923–1924 rates above those for 1921–1922, have not seriously broken into the city's good record of recent years.

The four cities in the East South Central states (table 5) show more unevenness than those of any other group. Louisville has attained the splendidly low figure of 1.9, and Birmingham has repeated the relatively low rate of 1923. Nashville, on the other hand, registers a rate of more than 20, and Memphis the amazingly high figure of 41.2. The latter city evidently has something to explain.

The cities in the West North Central states (table 6) make a very creditable showing.

The five cities in the West South Central states (table 7) have

shown in the last three years considerable tendency to improvement, but the average rates are still somewhat high as compared with

TABLE 9

Death rates from typhoid in 1924

Honor Roll (from 0.0 to 2.0 Deaths per Hundred Thousand)			
Fall River	0.0	Rochester	1.2
Hartford	0.0	Oakland	1.3
Worcester	0.5	Springfield	1.3
Trenton	0.8	Chicago	1.6
Akron	1.0	Syracuse	1.6
Milwaukee	1.0	Fort Worth	1.7
Omaha	1.0	Lowell	1.7
Richmond	1.1	Louisville	1.9
Cleveland	1.2	Spokane	1.9
First Rank (from 2.0 to 5.0)			
St. Paul	2.0	Seattle	3.2
Boston	2.1	Grand Rapids	3.4
Minneapolis	2.1	Bridgeport	3.5
Philadelphia	2.2	Kansas City, Mo	3.6
Dayton	2.4	Paterson	3.6
Cincinnati	2.5	Columbus	3.7
Providence	2.5	St. Louis	3.7
Jersey City	2.6	Indianapolis	3.9
San Francisco	2.6	Pittsburgh	3.9
Newark	2.7	Tacoma	3.9
Yonkers	2.7	Washington	4.3
Baltimore	2.8	Los Angeles	4.4
Des Moines	2.8	Toledo	4.4
Buffalo	2.8	Cambridge	4.5
Scranton	2.8	Youngstown	4.5
Norfolk	2.9	New Bedford	4.5
Detroit	3.0	Kansas City, Kan	4.6
New York	3.1		
Second Rank (from 5.0 to 10.0)			
Denver	5.1	Portland, Ore	6.1
New Haven	5.1	Camden	6.3
Reading	5.4	Birmingham	7.5
Houston	5.6	Dallas	8.2
San Antonio	5.8	Wilmington	8.3
Third Rank (from 10 to 20)			
New Orleans	10.0	Atlanta	15.0
Salt Lake City	10.1	Nashville	20.4
Albany	12.6	Memphis	41.2

Northern cities. Further improvement in the typhoid situation in this group may be anticipated when other Southern cities, such as Richmond, Baltimore and Louisville, are setting such a good example as pace-makers.

TABLE 10

Total average typhoid death rate (1910–1924)

	TOTAL POPULATION (57 CITIES)* ESTIMATED BY THE UNITED STATES CENSUS BUREAU METHODS	TYPHOID DEATHS	TYPHOID DEATH RATE PER 100,000
1910	20,996,035	4,114	19.59
1911	21,545,014	3,391	15.74
1912	22,093,993	2,775	12.56
1913	22,642,972	2,892	12.77
1914	23,191,951	2,408	10.38
1915	23,740,930	2,068	8.71
1916	24,205,359	1,842	7.61
1917	24,740,068	1,647	6.65
1918	24,971,278	1,557	6.23
1919	25,526,186	987	3.87
1920	26,154,013	921	3.52
1921	26,561,469	978	3.68
1922	26,936,843	851	3.15
1923	27,365,408	851	3.11
1924	27,868,865	856	3.07

* Twelve cities are omitted from this summary because data for the full period are not available.

The cities in the Mountain and Pacific states (table 8) are maintaining about the same relative position as for the last ten years, but on the whole do not show up as well as the cities on the Atlantic seaboard, although there seems no intrinsic climatic or racial reason why any difference in typhoid rates should exist. The 1911 to 1915 typhoid averages were not very different in the two sections, but in 1924 only three of the nine Mountain and Pacific slope cities had rates under 3, as contrasted with seven of the eleven cities on the Atlantic coast.

DISCUSSION

MEASUREMENT OF PIPE FLOW BY THE COÖRDINATE METHOD[1]

It is interesting to try to check the experimental results of Greve and Zucrow by theoretical computation, in that it affords an opportunity to check up on the customary hydraulic assumptions, showing what degree of confidence may be assumed, and what allowances must be made; and at the same time suggesting further points to be determined by experiment, and the accuracy to be expected.

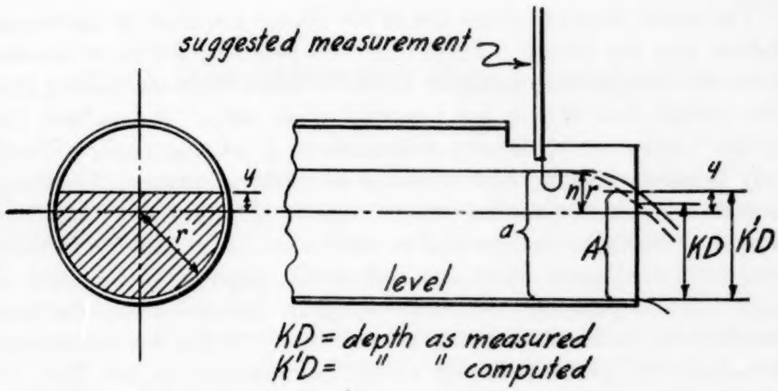
Neglecting friction, assuming that the drop in the end of the pipe is all converted into velocity, and allowing for the velocity of approach, the discharge would be as indicated in equation I of the accompanying figure. Solving this expression for the maximum in the usual manner, equation II is obtained, from which the drop for maximum flow may be computed. It will be noted that the depth of flow at the end of the pipe, as computed is larger than that obtained by measurement, suggesting that friction enters in. The difference is fairly constant at 0.05 k, which would not be unreasonable as a friction loss due to the increase in velocity in the drop curve, although there is some uncertainty as to whether the plane of the face of the pipe is actually the controlling section. It may be that measurements taken just above the drop curve would better agree with the theory.

It may therefore be suggested that in future experiments, simultaneous measurements be taken above the drop curve, as well as in the plane of the end of the pipe; that the experiment be tried of having the inside of the pipe for a short distance above the end turned and polished very smooth, and the end trued and slightly beveled, to eliminate friction; and that pipe of larger size be used.

Possibly fault may be found with the theory here offered because of lack of refinement, but the resulting approximate equation agrees quite closely in form with the empirical formula of the authors, and the values do not show more than the expected variation from actual measurement.

MILTON F. STEIN.[2]

[1] JOURNAL, March, 1925, page 306.
[2] Civil Engineer, Chicago, Ill.



Area at end of pipe:

$$A = \frac{\pi r^2}{2} + r^2 \sin^{-1}\frac{y}{r} + y\sqrt{r^2-y^2}$$

Area above drop curve:

$$a = \frac{\pi r^2}{2} + r^2 \sin^{-1} n + r^2 n\sqrt{1-n^2}$$

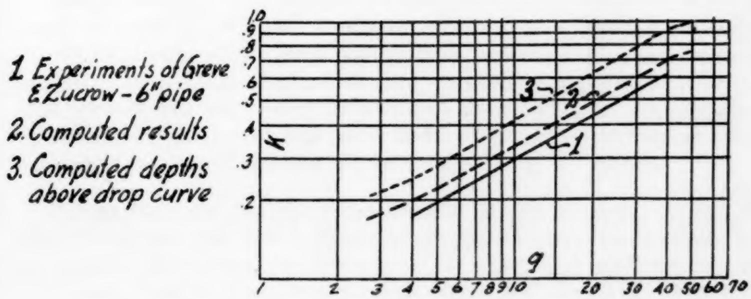
$$Q = \sqrt{2g(nr-y)}\left(1+\frac{A}{a}\right)A \text{ sec.ft. — neglecting friction} \qquad \text{I}$$

Differentiating and equating to zero:

$$\frac{A(a+A)}{a+2A} = A(nr-y)\sqrt{r^2-y^2} \qquad \text{II}$$

value of y from II to be substituted in I

Approximately: $q = d^{2.5}k^{2.05}$ cu. ft. per min. (diam. in inches)



DESIGN OF WASH WATER TROUGHS[3]

The writer does not make use of the energy acquired by the water falling into the trough. Mr. Miller was probably led to so assume from the cross section in figure 1, which shows the water falling into the trough, but this is for pictorial effect only. It has been the writer's endeavor to develop a formula on a rational basis, without any arbitrary assumptions or factor of safety allowance, this being one instance in engineering where a factor of safety as to capacity would as likely be detrimental as otherwise. Mr. Miller's formula was published some years ago, but in the form given included an experimental constant, which it would be inferred from the text, would have to be determined in each case. While the writer first attacked this problem for its theoretical interest, he felt that the publication of the formula, which basically is in accord with Mr. Miller's, but without an experimental constant, would be useful to the profession. The writer would be pleased to receive from filter operators, data as to the discharge of wash water troughs, which can be readily obtained where the wash water line is metered.

MILTON F. STEIN.[2]

[3] JOURNAL, April, 1925, page 411.

ABSTRACTS OF WATER WORKS LITERATURE

Frank Hannan

Key: American Journal of Public Health, 12: 1, 16, January, 1922. **The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.**

Lubrication. 1923 Report of Prime Movers Committee, Nat'l. Electric Light Association, p. 318. The preservation of the qualities of the lubricating oil while in use or in storage in the power plant, and means and methods for its filtration and purification. Most oil purifying devices will remove insoluble sludge. Few will completely remove soluble sludge nor remove to a great extent acids or alkalies. The continuous By-Pass System, Batch System and Continuous By-Pass Batch System of oil purification are described.—*A. W. Blohm.*

Burning of Liquid and Gaseous Fuels. 1923 Report of Prime Movers Committee, Nat'l. Electric Light Association, p. 297. Two important features of design for oil fired furnaces are volume and method of introducing air. Mechanical burners show the following advantages over the steam atomizing burners: saving of steam required for atomization; less excess air; better control; less trouble with tip stoppage; less maintenance cost for burners. Plants burning gas are at times troubled with sand, although not sufficiently so to warrant much expenditure for traps, etc., to effect removal. It is sometimes necessary to install a separator to remove oil carried by the gas.—*A. W. Blohm.*

Pulverized Coal. 1923 Report of Prime Movers Committee, Nat'l. Electric Light Association, p. 203. Contains opinions of a number of companies operating pulverized fuel-fired boilers, together with foreign comments on the subject. To attain the highest efficiency in the burning of coal by the pulverized process, the mixture of air and coal must be right. Results obtained by the use of pulverized coal have shown that higher continuous combined boiler and furnace efficiencies can be obtained.—*A. W. Blohm.*

Placing Concrete Lining in the Hetchy Hetchy Tunnels. W. F. Webb. Eng. News Rec., 94: 350–3, 1925. Approximately two-thirds of the 18-mile tunnel, 10 feet 3 inches, inside diameter, is being lined with concrete by the pneumatic placement method through 6-inch delivery pipe. The self-contained mixing and delivery plant on wheels which has been developed has been most successful. In one period of 29 working days 4002 linear feet of walls and arch requiring 7200 cubic yards of concrete was placed by one gun, which is believed to be a record for this class of work.—*R. E. Thompson.*

Behaviour of Débris-Carrying Rivers in Flood. F. N. Holmquist. Eng. News Rec., **94**: 362–5, 1925. General discussion of conditions governing scour by streams in flood and transportation and deposition of débris. Carrying capacity varies directly with velocity: weight of individual particles which can be moved or carried by running water under given conditions varies as the sixth power of the velocity. In general, depth of scour is under-estimated and width of scour over-estimated, the former being to bedrock more frequently than is realized.—*R. E. Thompson.*

Practical Rules for Concreting in Cold Weather. Portland Cement Association. Contract Record, **38**: 1141–6, 1924. Rules outlined and discussed. Fundamental factors are heat and moisture. Temperature of concrete should not drop below approximately 40°F. To insure prompt hardening, temperature should be not less than 60°F. when introduced into forms and not higher than 140°F. Best practice is to maintain temperature of 60°F. within enclosure for 5 days after pouring and temperature of 40°F. for 10 additional days. Table included showing strength of concrete in 1–21 days at temperatures of 40–70°F.—*R. E. Thompson.*

Thrust Boring for Pipes. Munic. Eng., **74**: 587, 1924. Thrust boring machine and its operation described and illustrated. Straightforward 40-foot road can be bored in 4 hours by 4 men.—*R. E. Thompson.*

Recent Progress in Water Purification. Norman J. Howard. Contract Record, **38**: 1292–4, 1924. Progress in purification is reviewed. Double filtration has been adopted in several places to offset increased pollution and found to give highly satisfactory results. The importance of agitation in the coagulation of slightly turbid and moderately colored water has recently been demonstrated. In one instance 20 minutes slow stirring and 1 hour subsequent settling gave better results than 6 hours quiescent subsidence alone. At Columbus it was found that agitation at rate of 0.6 feet per second gave highest efficiencies and that increased quantities of coagulant were required at lower velocities. Temperature apparently has little influence on coagulation. Many cities which cannot conform to proposed U. S. P. H. S. water quality standards have well supervised supplies and are practically free of typhoid. Super-chlorination and subsequent dechlorination is a certain remedy for taste troubles.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Storage Dams on the Metis Lakes. W. L. Reford Stewart. Cont. Rec., **39**: 92–4, 1925. Illustrated description of construction of dam consisting of stone-filled crib, 422 feet long and 64 feet wide, with maximum height of 37 feet, impounding some 3,000,000,000 cubic feet of water covering area of approximately 20 square miles.—*R. E. Thompson.*

A Powerful New 3-Jet Sand Washer. Cont. Rec., **39**: 19–20, 1925. Illustrated description of new triple jet "Peebles" patent automatic sand washer recently installed in Liverpool, Eng. The machine weighs 28 cwt. and will wash, continuously, minimum of 12 tons of sand per hour, when supplied with

water at 10 pounds per square inch, together with very small quantity of 40 pounds per square inch. Principle is same as smaller "Peebles" sand washers, which operate with water at 5 pounds per square inch.—*R. E. Thompson.*

Driving Small Tunnel Under Air Pressure at Seattle. Eng. News Rec., **94:** 401-2, 1925. Difficulties due to air losses are being experienced in driving tunnel under Duwamish waterway to increase city's supply to southwestern section of city. Air escapes so rapidly that compressors take 4000 cubic feet of free air per minute to maintain pressure of 25 pounds per square inch in tunnel, which is 8 feet in diameter. The air comes to surface of waterway anywhere up to 100 feet from point directly above heading. Construction methods employed are outlined.—*R. E. Thompson.*

Concrete Pipe for Water Under Pressure. F. F. Longley. Cont. Rec., **38:** 1149-51, 1924. Essential characteristics are density, water tightness and smoothness. Advantages are higher carrying capacity, resistance to corrosion, and absence of tuberculation. Metal to metal joints are most satisfactory and each must be an expansion joint to prevent contraction cracks. Concrete pipe will withstand substantial pressure without visible leakage.—*R. E. Thompson.*

A Modified Methyl Orange Indicator. K. C. D. Hickman and R. P. Linstead. J. Chem. Soc., **121:** 2502-6, 1922. From Chem. Abst., **17:** 700, March 10, 1923. By dissolving 1 gram of methyl orange and 1.4 grams xylene cyanole FF in 500 cc. 50 per cent alcohol, an indicator solution is obtained which has all the desirable qualities of methyl orange and more characteristic end point. In titrating sodium hydroxide with 0.1 N hydrochloric acid, using 2 drops of indicator, solution remains green to within 2 drops of end point, then becomes grayish green and steel-gray at end point, which is at pH 3.8. Further addition of acid produces a magenta shade. End point corresponds to salmon-pink shade with methyl orange. Indicator can be used to advantage for all titrations where methyl orange has been recommended, but will not give satisfactory results with weak acids.—*R. E. Thompson.*

Alterations and Corrosions Observed in Cast-Iron Water Mains. A. A Bado and V. J. Bernaola. Anales asoc. quím. Argentina, **10:** 168-77, 1922. From Chem. Abst., **17:** 718, March 10, 1923. Analyses of mixture of oxides filling pits in cast-iron water mains at points corroded by electrolysis, and of the iron itself, showed that all constituents were oxidized except carbon.—*R. E. Thompson.*

The Threshold Value of Acid Taste. G. Liljestrand. Arch. néerland. physiol., **7:** 532-7, 1922. From Chem. Abst., **17:** 774, March 10, 1923. Acid taste is not due to any definite pH but rather to titration capacity of solution. Strong mineral acids taste acid at pH 3.4-3.5 and weak organic acids at 3.7-3.9. Buffer-salt solutions of equal pH taste much more acid and taste persists longer in mouth. Buffer solutions of acetic acid and sodium acetate and of citrate and sodium hydroxide give acid taste at 5.6 and 6.3 respectively.—*R. E. Thompson.*

Odor and Its Relation to Molecular Structure. R. DELANGE. Bull. soc. chim., **31**: 589–630; Rev. sci., **60**: 505–43, 1922. From Chem. Abst., **17**: 775, March 10, 1923. Discussion of classification and measurement of odors and relation between odor, chemical constitution, and physical properties.—*R. E. Thompson.*

Examination of a Bronze Wheel Manufactured 600 B.C. O. BAUER, E. WETZEL, and O. VOGEL. Mitt. Materialprüfungsamt, **39**: 57–65, 1921. From Chem. Abst., **17**: 718, March 10, 1923. Illustrated description of well-preserved wheel and corroded extra hub discovered in 1919.—*R. E. Thompson.*

Diurnal Variation in the Hydrogen-Ion Concentration of Littoral Sea Water. R. LEGENDRE. Compt. rend., **175**: 773–6, 1922. From Chem. Abst., **17**: 777, March 10, 1923. Diurnal variation of oxygen content ascribed to photosynthesis of plankton and other algae, increasing pH by consumption of carbon dioxide, and liberating oxygen.—*R. E. Thompson.*

A Colorimeter for Bicolorimetric Work. VICTOR C. MYERS. J. Biol. Chem., **54**: 675–82, 1922. From Chem. Abst., **17**: 781, March 10, 1923. Description of wedge colorimeter, with magnifying lens and attached lamp house.—*R. E. Thompson.*

The Laboratory Preparation of A Purified Hematoxylin. A. H. DREW. Brit. J. Exptl. Pathol., **3**: 307, 1922. From Chem. Abst., **17**: 782, March 10, 1923. Commercial hematoxylin is boiled with zinc dust to remove an impurity and reduce it to leuco compound.—*R. E. Thompson.*

Chart for Conversion of Colorimetric Readings into Hydrogen-Ion Concentration. J. F. McCLENDON. J. Biol. Chem., **54**: 647–53, 1922. From Chem. Abst., **17**: 783, March 10, 1923. Chart developed rendering buffer mixtures of known pH unnecessary. Original must be consulted for details.—*R. E. Thompson.*

The Effect of Various Culture Media Upon Acid Production by B. lactis aërogenes. E. WOLFF. Z. Kinderheilk., **31**: 226–35, 1922. From Chem. Abst., **17**: 788, March 10, 1923. In culture media varying in sucrose concentration (from 1 to 20 per cent) and constant peptone content, acid production remained practically constant. With constant sugar content and variable amounts of peptone, acidity produced was proportional to concentration of peptone. In whole milk medium with 12–17 per cent sugar, acid formation decreased as concentration of sugar increased.—*R. E. Thompson.*

The Theory of Lubrication. W. B. HARDY. Brit. Assoc. Advancement of Sci., 4th Rept., 1922, 185–203; cf. C.A. 16, 2187. From Chem. Abst., **17**: 840, March 10, 1923.—*R. E. Thompson.*

What is Wet Steam? Chem.-Ztg., **46**: 1104–5, 1922. From Chem. Abst., **17**: 839, March 10, 1923. Popular conception is that wet steam contains strikingly

large quantities of water as liquid, which cause water-hammer, etc., in steam system; but technically it may be considered, as steam with even small amounts of liquid water suspended in it. Water in form of mist or of gross particles is sucked out of boiler with escaping steam, and carries with it alkali or other solids contained in feed water. Even a superheater will not completely vaporize this liquid water, as it assumes the spheroidal state and passes through unchanged. Such water is later removed from system by traps, and is often erroneously referred to as "condensate." Water so carried causes diminished efficiency of steam, utilizes superheater as evaporator, makes use of large number of traps necessary, corrodes engine parts, forms deposits of scale, increases lubricating expense, prevents accurate steam measurements, etc. Its elimination would effect saving of 5–20 per cent in fuel alone. It is claimed that a heat-recoverer, "Gestra," made by Gustav F. Gerdts, Bremen, prevents these difficulties by application of new method. Steam is divided into two streams before leaving boiler, each of these subdivided into two angular jets which impinge on each other so that water and steam are separated, the water falling back into boiler, thus conserving its heat. As superheaters receive only dry steam their efficiency is increased as much as 50 per cent.—*R. E. Thompson.*

The Pumping of Liquids in Chemical Plants. C. S. Robinson. Ind. Eng. Chem., **15:** 33–8, 1923. From Chem. Abst., **17:** 839, March 10, 1923. Robinson covers briefly the construction, design and field of usefulness of reciprocating, centrifugal, and rotary or gear pumps, blow-cases, air lifts, and siphons. —*R. E. Thompson.*

The Deterioration of Chloride of Lime. L. Gizolme. Ann. fals., **15:** 148–9, 1922. From Chem. Abst., **17:** 856, March 10, 1923. Three lots of bleaching powder kept in wooden casks in covered shed showed available chlorine content of 24.2 and 12.0 per ce 21.4 and 14.6, and 34.0 and 28.8 at intervals of 266, 211, and 190 days respectively, equivalent to loss of 0.046, 0.034 and 0.027 per cent per day respectively. Two months later the second and third lots contained 12.2 and 27.4 per cent, showing further loss of 0.040 and 0.023 per cent per day respectively.—*R. E. Thompson.*

The Control of Combustion. Relation Between the Composition of the Fuel and of the Flue Gases. Determination of Excess Air. Volume of Air Used for Combustion and Volume of Gases Produced. G. Deladrière. Rev. metal., **19:** 599–602 (Abs.), 1922. From Chem. Abst., **17:** 867, March 10, 1923.—*R. E. Thompson.*

Colloidal Fuels: Their Preparation and Properties. A. E. Dunstan. Brit. Assoc. Advancement of Sci., 4th Rept., 1922, 380–2. From Chem. Abst., **17:** 867, March 10, 1923. Brief note.—*R. E. Thompson.*

Contradictions and Errors in Analytical Chemistry. I. The precipitation of aluminium with thiosulphate and its separation from iron. F. L. Hahn and G. Leimbach. Ber., 55B, 3161–3, 1922. From Chem. Abst., **17:** 699, March

10, 1923. Precipitation of aluminium by boiling slightly acid solution with thiosulphate and subsequent addition of ammonium hydroxide, is not quite complete and iron is likely to be carried down with the alumina. If boiling is not continued too long there is but little aluminium left in solution, and if phenylhydrazine is substituted for ammonium hydroxide there is less danger of contamination with iron.—**II. Old thiosulphate solutions is volumetric analysis.** F. L. HAHN and H. WINDISCH. Ibid., 3163–5.—It has been assumed that thiosulphate solutions gain in strength because of the slight acidity of the water, possibly due to carbon dioxide, and that the acid liberates thiosulphuric acid which breaks down into sulphurous acid and sulphur. Windisch was unable to detect sulphite in old thiosulphate solutions, and found that addition of little alkali hydroxide tends to prevent decomposition of thiosulphate and the gain in strength on standing.—*R. E. Thompson.*

A Rapid Gas-Volumetric Method for Determining Carbonic Acid in Carbonates. C. TUBANDT and H. WEISZ. Chem.-Ztg., **46**: 1105, 1922. From Chem. Abst., **17**: 700, March 10, 1923. Patented apparatus described which permits determination of carbon dioxide content in 15 minutes. Sample is decomposed with slight excess of hydrochloric acid and solution boiled vigorously to remove carbon dioxide, the vapors being passed through a condenser and the volume of carbon dioxide read directly.—*R. E. Thompson.*

Water Hammer in Pipes. Munic. Eng., **75**: 238, 1925. Brief illustrated description of non-concussive self-closing tap.—*R. E. Thompson.*

Sewage Pollution of the Illinois River. S. A. FORBES. Outdoor America, 3: 35–36, 1924. Chicago Sanitary Canal opened in 1900 and by midsummer of 1911 upper 10 miles of Illinois River was practically a septic tank. Gases of bottom sludge, 79 per cent CH_4, 19 per cent CO_2, 1.2 per cent N, 0.56 per cent CO, 0.03 per cent O_2. In 1918 pollution had moved down 60 miles. River nearly deserted by fish as far as Peoria lakes, 93 miles down stream. Offensive pollution, as shown by stinking sludge and sewage worms had moved from Ottawa to Laon, 51 miles.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Filtration of Water by Sand. R. CAMBIER. Ann. d'Hyg., November, 1924, pp. 641–664; Water and Water Eng., **27**: 31, 1925. Sand filters were installed in old ducal palace of Venice. In France filtration was adopted late, the earliest filters being composed of sand, sandstone, charcoal and sand and all used under pressure—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Low Heads. E. MAURIEN. Arts et metiers, October, 1924, pp. 378–382; Water and Water Eng., **26**: 506, 1924. Preliminary study of the characteristics of low heads for power purposes. Refers to influence of flood water when height above dam remains fixed while height below dam is considerably increased.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Project for Swimming Pool at Rouen. ANON. L'Eau, **17**: 93, 1924. Municipal installation to be supplied with warm water heated at nearby municipal

incinerator. Constructed according to requirements of "Federation centrale de natation." Recirculation and aëration by cascades. It is expected to filter volume of water equal to pool contents in 10 hours.—*Jack J. Hinman, Jr.* *(Courtesy Chem. Abst.)*

Iodine and Goiter in Macomb County, Michigan. E. F. ELDRIDGE. Pub. Health (Michigan) **12** (n.s.): 328–333, 1924. Spotted character of goiter incidence within county considered due to variations in iodine content of drinking water. Where Berea sandstone outcrops, iodine is found in greater amount and goiter is less. Hardpan formation above Berea sandstone keeps iodine-containing water from getting into water bearing gravel found in northwestern part of county.—*Jack J. Hinman, Jr.* *(Courtesy Chem. Abst.)*

Germ-Killing Effects of Ultra-Violet Measure. Ind. Eng. Chem. **17:** 2, 160. February, 1925. Study made by U. S. Bureau of Standards. Range covered was from just beyond limit of visible spectrum down to shortest wave lengths emitted by mercury-vapor arc in quartz lamp. Shortest waves had greatest killing effect, but killing action existed at lengths 0.000365 mm. which is almost as long as shortest waves visible. Rays of sufficient intensity killed B. Coli with exposure of less than 1 second. Minimum intensity of light required when using 320 watt mercury lamp was found at point not to exceed 6 inches from lamp. When intensity was lowered, killing action was greatly retarded, 75 to 80 seconds exposure being required. At still lower intensity, stimulation of bacterial growth rather than killing effect was indicated. Additive intermittent exposures appeared to be as effective as a single continuous exposure, provided total period of exposure is the same.—*Linn H. Enslow.*

Anaërobic Sporulating Thermophiles. S. A. DAMON and W. A. FEIRER. Jour. Bact., **10:** 1, 37, January, 1925. New group of anaërobic sporulating bacteria has been isolated from well-rotted horse manure. A few of cultures had optimum growth between temperatures 37° and 55°C., but produced no acid or gas from lactose media. None were pathogenic to guinea pigs.—*Linn H. Enslow.*

Spontaneous Combustion of Coal. J. D. DAVIS and J. F. BYRNE. Ind. Eng. Chem., **17:** 2, 125, February, 1925. Fine coal of a given quality, because of greater surface area per unit volume or weight, heats much more rapidly than larger lumps. Two stages of reactions are involved in spontaneous heating of coal: (1) mechanical adsorption and formation of solid-oxygen compounds predominating at ordinary temperatures and generating only a small amount of heat per unit of oxygen used; (2) subsequent breaking up of unstable oxygen compounds formed in first stage, with evolution of 60 to 70 per cent of total reaction-heat. Temperature at which spontaneous heating of bituminous coal of Pittsburgh district begins is apparently 25±°C. (77°F.), a figure which is expected to apply for Pocahontas coal also, unless latter is of very friable nature, disintegrating readily within pile. Rate of heating is proportional to amount of oxygen used. Heating tendencies of anthracite are small.—*Linn H. Enslow.*

Deterioration of Coals Under Different Storage Conditions Relative to Effect on Burning Qualities. N. R. BEAGLE. Ind. Eng. Chem., **17**: 2, 123, February, 1925. *Rules Governing Storage:* (1) Maximum depth of piles to be 10 feet. (2) Do not put two sizes of screenings in same pile, using great care to prevent segregation in strata of coarse and fines. (3) Do not mix coals from different mines in one pile. (4) Keep foreign material out of piles and do not pile against walls, around poles, etc. (5) Do not store cars of inferior looking screenings—burn them immediately instead. (6) Small vertical pipes at intervals in pile allow taking of temperatures to check conditions. Coal heating to above 150°F. (66°C.) should immediately be repiled or loaded out for burning. *Loss Of Efficiency of Stored Coal and Effect on Boiler Operations:* Observations covering number of years indicate total loss including double handling of at least 10 per cent. For stored coal, higher draft, higher uptake temperature, and lower carbon-dioxide readings are required than for fresh coal from same mine; this even after a short storage period. Actual operating efficiency shows greater losses during storage than may be accounted for by loss of B.t.u. value alone, which ranges from 1000 to 2000 B.t.u. Volatile matter loses from 3.5 to 10 per cent, depending upon character of coal; figures given apply to mid-western coals. Ash from stored coal has greater tendency to fuse to stoker-links and choke air-ways. Operation and maintenance are attended with greater difficulty. Coal burns unevenly; often a boiler, apparently with good fire, may drop half its load within 5 minutes because fire-bed has burned in two. Operation must be very closely watched, fuel bed cut down in depth, and draft increased. Ordinarily a lower capacity must be carried on boilers, therefore requiring extra units to be kept in operation. *Under-Water Storage:* Coal kept under water deteriorates very slowly. Tendency to slower ignition on stoker installations is not so noticeable. Water used should contain no mud in suspension. Last 25 per cent of the coal removed will be of considerably lower quality because of higher percentage of fines accumulating at bottom of pit.—*Linn H. Enslow.*

Chemical Treatment of Refrigeration Brines to Prevent Corrosion. EMERSON P. POSTE. Ind. Eng. Chem., **17**: 2, 131, February, 1925. Strong brines are less corrosive than dilute. Calcium chloride brines turn acid in contact with air and should be as free from magnesium chloride as possible. Corrosiveness of brines is reduced by keeping them alkaline. Lime or caustic soda may be added to calcium chloride brines; soda ash may be used in sodium chloride, but not in calcium brines. It is practical to hang a container or bag holding caustic soda in the tanks where circulation is rapid, but lime must be added in form of emulsion, or slurry. With strong brines (sp. gr. 1.20) and temperature of 10°F. (−12°C.) calcium chloride brine may be rendered 0.01 × N and sodium chloride 0.03 × N alkaline, either being sufficient to materially suppress corrosion. Weaker brines may be raised to higher alkalinities. *Recommended Practice:* (1) Use only calcium chloride free of magnesium salts. (2) Maintain a brine of 1.20 (sp. gr.). (3) Either calcium or sodium brines should be treated with high grade quick-lime on basis of 10 pounds of lime per 1000 gallons of brine in the system; or with caustic soda on basis of 13 pounds per 1000 gallons. (4) Lime, if used, should be added as emulsion at point of rapid circulation. (5) Additional lime or caustic should be added as fre-

quently as necessary to maintain in calcium chloride brines alkalinity between 0.015 and 0.025 N and in sodium chloride brines, between 0.03 and 0.04 N.—*Linn H. Enslow.*

Deterioration and Spontaneous Combustion of Coal in Storage. S. W. PARR. Ind. Eng. Chem., **17**: 2, 120, February, 1925. Coal in storage gains 7 to 9 per cent in weight due to oxidation. Actual loss in heat value of from 8 to 15 per cent may occur. The more dense coals and those carrying the least free or textural moisture disintegrate least during storage and have least capacity for oxygen absorption and consequent heating. Anthracite has a minimum capacity for oxygen and storage of same in any quantity, without danger of loss of combustion, is permissible. In storing bituminous coal, it is of fundamental importance to exclude dust or duff, i.e., material passing a $\frac{1}{4}$-inch screen. To prevent heating to a dangerous degree, there must be either very free circulation or no circulation of air through the pile: safer procedure is to exclude all air circulation. With actual maintenance of conditions of no air or free air, no limit exists for height of storage piles. In case of doubt, use heights 10 to 15 only, so that hot spots can be removed more readily from the pile. The question of type or class of bituminous coal has little significance compared with importance of maximum voids, as secured by screened and sized lump, accessibility of air currents, and absence of extraneous heat. Fundamental requirement is absence of fine material mixed with the screenings. Coal in storage which has acquired a temperature of 75°C. has reached a danger zone and unless conditions are altered, will proceed to point of ignition. Even a matter of a few days at this temperature results in loss of heating value.—*Linn H. Enslow.*

The Oxidation of Coal at Storage Temperatures. S. W. PARR and R. T. MILLNER. Ind. Eng. Chem., **17**: 2, 115, February, 1925. Coal in storage increases in weight apparently because of oxygen adsorbed upon and somewhat within its surface. A seeming saturation point at about 8 per cent increased weight is reached, with corresponding apparent, though not real, loss of heat value. At slightly increased temperatures due to natural or artificial heating within the pile, the adsorbed oxygen goes over into actual chemical combination, with formation of carbon dioxide and water and corresponding actual loss of heat value.—*Linn H. Enslow.*

Critical Oxidization Temperature of Coal in Storage. S. W. PARR and C. C. COONS. Ind. Eng. Chem., **17**: 2, 118, February, 1925. Critical oxidization temperatures for Illinois coals lie within range 138° to 143°C., while that for Pocahontas Coal is 202°C. It seems fair to conclude that when coal in storage, with free access of oxygen, reaches critical temperature, ignition will speedily follow.—*Linn H. Enslow.*

NEW BOOKS

The Law Relating to Public Service Undertakings. F. N. KEEN. London: King and Son. 8vo, pp. 320. 15s. Reviewed in Munic. Eng., **75**: 191, 1925. —*R. E. Thompson.*

Agricultural Hydraulics. P. L. Salvador and P. Frick. Dunod, editeur, 47–49. Quai des Grands Augustins, Paris.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

The Concrete Year Book, 1925. Edited by Oscar Faber and H. L. Childe. London: Concrete Publications Ltd. 3s. Reviewed in Munic. Eng., **75**: 55, 1925.—*R. E. Thompson.*